Abstract

APRONS OF LEAD: EXAMINATION OF AN ARTIFACT ASSEMBLAGE FROM THE *QUEEN ANNE'S REVENGE* SHIPWRECK SITE

by

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In terms of artillery from shipwreck sites, gun tubes are typically the most well researched artifacts. Small finds like lead cannon aprons get significantly less attention but they too can reveal a great deal of information about past technologies and behaviors. The goal of this project is to shed light on this little researched class of artifacts, using the assemblage from the *Queen Anne's Revenge* shipwreck site as a case study.

Historical accounts agree that an apron's primary function was to serve as a touchhole cover to keep powder dry and chambers debris free when a ship's guns were not in use. Beyond this, little is known about aprons. Interestingly, more than half the aprons in the QAR assemblage bear inscribed markings that are not explained by this primary function. Documentation and analysis of the *Queen Anne's Revenge* aprons will not only fill gaps in the current knowledge of 18th century naval ordnance, it will also help tell the story of the unknown sailors who marked them.

APRONS OF LEAD: EXAMINATION OF AN ARTIFACT ASSEMBLAGE FROM THE *QUEEN ANNE'S REVENGE* SHIPWRECK SITE

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CHAPTER 1: INTRODUCTION

Introduction

In November 1996, shipwreck remains were found off the North Carolina coast near Beaufort Inlet. The state assumed stewardship of the wreck shortly after its discovery and it has since become the subject of the largest scale underwater excavation in North Carolina. Years of speculation and debate ensued over the vessel's identity, but with ongoing recovery and research, the wreck is now commonly believed to be the remains of Blackbeard's flagship, *Queen Anne's Revenge* (QAR), which sank in 1718 (Wilde-Ramsing 2006, 2009).

Thousands of artifacts have been recovered from the QAR, a significant portion of which classify as artillery. Twenty-four cannon have been identified on site; of those, 13 have been recovered and 5 have completed conservation treatment. A large number of cannon accessories, such as tompions, aprons, and wadding, have also been recovered (Lusardi 2006; Henry 2009:12-13). The gun tubes tend to generate the most interest; they are large scale examples of naval technology, typically well researched, often written about, and crowd pleasing museum exhibits.

Small finds do not get nearly as much attention, but they too can reveal a great deal of historical and cultural information; such is the case with the QAR cannon aprons. When a ship's gun was not in use, a lead apron (Figure 1) was fastened over the touchhole to keep the powder dry and the vent debris-free (Smith 1627, 1691:89; Binning 1677:109; Seller 1691:158; Povey 1702:43-46; Smith 1779:9; Tousard 1809:132,136; Simmons 1812:104; Adye 1813:2; James 1821:19; Blackmore 1976:218; Boudriot 1986:169; Caruana 1994:73; Brown 1997:105; Henry 2009:13). If these references are accurate, this definition constitutes a primary function for the QAR cannon aprons. Interestingly, many aprons in this assemblage appear to bear inscribed markings that are not explained by their primary function. The markings range from simple linear tick marks to ornate designs and letters. The aprons are made of lead or a lead alloy which makes them very malleable. Due to the material's softness, some markings could have been formed in the wrecking process, during the post-depositional period, or even during excavation and conservation. The more ornate designs seem purposely inscribed and artistic, like graffiti. The majority of the markings, however, are not immediately discernible as either post-depositional accidents or as graffiti; they are ambiguous. Regardless, the markings indicate the cannon aprons had a secondary function associated with a different level of meaning, likely unrelated to their use as touchhole covers. The focus of this study is to investigate the functions and levels of meanings of the QAR cannon aprons using historical and archaeological methods.

FIGURE 1. Detail of "Under the *Pallas'* Half-Deck" by Gabriel Bray, showing an apron lashed to a gun (Courtesy of National Maritime Museum, Greenwich, London).

Research Questions and Hypotheses

The QAR cannon aprons are a small collection in terms of artifact assemblages; only 13 were recovered as of the spring 2011 field season, but they may be the largest collection of aprons to come from a single site. It is possible that aprons from other sites were misidentified or have remained unidentified. There is little previous research on cannon aprons and vent covers, in part because they might be easily mistaken for lead patches or sheathing. The present study may help prevent future misidentifications and add to a better understanding of not just the QAR collection, but other maritime artifact assemblages as well. The following research questions have been formulated with this goal in mind.

- Research Question 1: Historically speaking, what was a cannon apron and how was it used?
    - What was its primary function?
    - How and when were aprons made?
    - Of what material were they composed?
    - Where were they manufactured?
    - When were aprons first used on cannon and for how long?
    - Were there different types of aprons depending on gun type, time period, and/or geographic region?

- Research Question 2: Based on archaeological findings, do the QAR aprons seem to have been manufactured and used as described in historical accounts? If not, how were they used differently?
    - Is their provenience on the site indicative of their primary function, either by associated artifacts or by general location?
    - Were the aprons in use at the time of wrecking or were they in store as extras?
    - Is it possible to determine which aprons were used on which guns?
    - Are the markings on the QAR cannon aprons cultural, incidental or both?
    - If the markings are both cultural and incidental, is it possible to distinguish between them and how?
    - If the markings prove to be cultural, or deliberate, does their presence indicate a secondary function? If so, what is this secondary function and for whom did the aprons serve this purpose?

- Could any surface markings be related to the manufacturing process or the aprons' primary function as touchhole covers?
- Are there similar markings on aprons from other sites, or are they unique to the QAR aprons?

- Research Question 3: The original surfaces of the aprons are extremely important in studying the markings; what chemical and physical variables have affected these surfaces?

    - What are some common corrosion products that form on lead and lead alloys in sea water?
    - Can elemental analysis be used to identify the corrosion products on the QAR aprons and determine whether or not they are stable?
    - What effects have the corrosion products had on the preservation of the aprons' surface metal and is the interpretation of the markings compromised by these effects?
    - Which conservation treatments have been used on the aprons and what is their impact on the objects' surfaces and the interpretation of surface markings?

Preliminary investigations of the aprons and related literature made it possible to formulate hypotheses for certain aspects of the research questions. These hypotheses were then tested using the theoretical and methodological framework described in Chapters 2 and 3. Chapters 4 and 5 present the literature review to establish background information on vessel and site history. Chapter 6 summarizes the literature review on artillery and apron history, addressing Research Question and Hypothesis 1. Chapter 7 describes the apron documentation and Chapter 8 offers an interpretation of these results, addressing Research Questions and Hypotheses 2 and 3.

- Hypotheses for Research Question 1:
    - Lead aprons were used primarily as touchhole or vent covers for guns during the height of the muzzle loading artillery era.
    - Changes in apron form, as evident from different archaeological examples, reflect changes in artillery design.

- Hypotheses for Research Question 2:
    - The QAR aprons were used in accordance with historical descriptions; based on their primary function as vent covers, apron proveniences on site should closely correspond to gun proveniences.

- Documentation of the QAR aprons will reveal different categories of aprons, based on dimensions, which will correspond to different gun types.
- There are both cultural and non-cultural markings on the aprons, the former of which is related to a secondary function or level of meaning, which may not be common but is not necessarily unique to the QAR.

- Hypotheses for Research Question 3:
    - Corrosion in itself has had little impact on the surface of the QAR aprons.
    - Chemical and mechanical removal of corrosion, however, has impacted the aprons by both eliminating material that could confuse interpretation (such as concretion) and by causing post-depositional surface markings that could enhance confusion.

Conclusions

A review of 18th century artillery literature reveals a gap in documentation regarding contemporary cannon accessories, specifically aprons. Detailed descriptions of how cannon aprons were made and used are extremely hard to locate; this is reason enough to complete the present study. That the QAR aprons (and potentially aprons from other sites) have inscribed surface markings and/or graffiti provides another reason why this research is important. The markings were likely made by someone who did not leave a written history. As Martin (1997:2) states, "Academic writers - ancient and modern - tend at times to be impractical and unworldly, and few have engaged in the workaday business of building ships….craftsmen who did so engage rarely had much time and inclination for writing, or were illiterate - a disability which seems to have occasioned them little practical disadvantage." The same sentiment can be applied to the individuals who manufactured and used the QAR cannon aprons. Apron documentation and analysis will fill gaps in the current knowledge of 18th century naval ordnance and thus help tell the story of the unknown sailors or gunners who marked them.

CHAPTER 2: THEORETICAL APPROACHES

Introduction

Material culture definitions are broad reaching, and similarly, Material Culture Studies is a broad and interdisciplinary field incorporating research from many related fields, such as art history, museum studies, anthropology, archaeology, etc. (Schlereth 1982; Lubar and Kingery 1993; Knappett 2005). Theoretical approaches used in material culture study are also interdisciplinary and drawn from several fields. Much of archaeological theory treats material culture too narrowly, despite the fact that archaeology seems to depend on the study of artifacts. As Knappett (2005:1) states:

> It is perhaps surprising…that archaeology, while developing ever more sophisticated methodologies for artifact study, has not yet constructed similarly sophisticated theoretical models for understanding the roles of artifacts in human societies. So complex and daunting is such a task that it must inevitably be interdisciplinary in its scope, drawing upon cognitive science, psychology, sociology, anthropology, and history.

Theory is important in all sciences because it provides a way to organize data in a meaningful way. Theories can be hypothetical or predictive. They are the overarching abstractions that form conceptual frameworks for scientific research. Archaeology is, in its strongest applications, an interdisciplinary science, and many of its theories are drawn from interdisciplinary concepts. The study of the QAR cannon aprons is no exception. According to Trigger (2006), "It is a fundamental tenet of science that nothing is significant by itself but only in relation to hypotheses; hence only theories can explain phenomena." The goal of this project is to explain the "phenomena" that are the QAR cannon aprons using a blend of material culture theory and an adaptation of behavioral archaeology theory, as conceptualized by Michael Schiffer in the 1970's.

Material Culture Studies

The definition of material culture is a slippery one; it has been expanded and contracted to fit changing ideological trends, but consistently includes some mention of physical objects made, modified, or used by people (Schlereth 1982:3). Folklorist Henry Glassie (1999:41) defined material culture more eloquently as "the conventional name for the tangible yield of human conduct." By these and most other definitions, the QAR cannon aprons can be classified as material culture. The aprons are physical objects made by people; they are elements of Glassie's "tangible yield," and therefore understanding material culture theory is highly relevant to their study.

Background

The origins of Material Culture Studies in the United States can be traced to the mid-19th century. Over the years the field has gone through three developmental phases: the age of collection, the age of description, and the age of interpretation (Schlereth 1982:6). The first phase, the age of collection (1876-1948) was characterized, as its name suggests, by a movement toward collecting "elite" objects like antiques and works of art. A number of indoor and outdoor museums were opened during this period to serve as repositories for the newly collected objects. The highest priority was reserved for pieces considered the most unique and/or the most aesthetically appealing (Schlereth 1982). Artifacts known to be associated with important historical events or people were also desirable. This mentality began to change with the advent of the second phase, the age of description.

In the age of description (1948-1965), common and everyday objects began to gain importance over the elite. Studies in folklife, vernacular architecture, and the history of technology were born. The focus on an object's uniqueness was replaced with a focus on creating typologies and classifications for groups of common artifacts (Schlereth 1982).

The age of interpretation (1965-present) is the current phase of Material Culture Studies. During this phase scholars began connecting artifacts with the behavior of people who made them. Objects of material culture were not just being collected, preserved, and described; they were being analyzed for a deeper meaning. The movement toward interpretation facilitated methodological and theoretical growth for the field. In the historiographical first chapter of *Material Culture Studies in America*, Thomas J. Schlereth (1982) described nine theoretical approaches that developed in the field's third phase: the art history, symbolist, cultural history, environmentalist, functionalist, structuralist, behavioral, national character, and social history approaches. Of these paradigms, the symbolist, cultural history, functionalist, structuralist, and behavioral/poststructuralist approaches are considered more relevant to the QAR cannon aprons study.

In the years since Schlereth's historiography, the fields of Material Culture Studies and Historical Archaeology have become increasingly focused on comparative rather than particularistic studies. While paradigms used in the earlier decades of the age of interpretation are still relevant, the "scale of analysis has expanded from sites to landscapes, from structures to systems, and from artifact typology to material culture's role in expressing beliefs and identity" (Joseph 2012:1).

Theoretical Approaches

Symbolist Approach

The symbolist approach to Material Culture Studies is rooted in humanism and based on the premise that certain artifacts possess meaning, not only in terms of their function, but also as symbols of societal worldviews. Symbolists believe that objects of material culture are imbued with the imagination of their makers and can be examined for "unconscious beliefs, ideas, taboos, fantasies, projections, values, and hidden meanings" (Schlereth 1982:45). Objects are believed to contain both concrete factual information and abstract symbolic information. Symbolist theory lends itself more easily to qualitative rather than quantitative analysis (Schlereth 1982:44). It relies heavily on myth and is closely related to theories used in literary studies. Critics of this theoretical approach point out that the data collected is mostly subjective and that it is too easy to ascribe false symbolic meanings to artifacts (Schlereth 1982:46). Symbolist material culturists must be careful not to project their own worldviews and imaginations onto the subjects of their research.

Cultural History Approach

In contrast to the symbolist approach, the cultural history approach to material culture is a more empirical model. Cultural historians generally seek to reconstruct portions of the past underrepresented by historical documentation. This approach is characterized by exhaustive data collection including fieldwork, as much historical research as possible, and sometimes experimental archaeology. Outdoor living history museums are typical examples of the end results of a cultural history approach to material culture. A negative aspect of this theory is that it tends to recreate a static view of history rather than a dynamic one. Some scholars find the concept of a static history unrealistic and inaccurate, so proponents of the cultural history approach were split into "static reconstructionists" and "process reconstructionists" (Schlereth 1982:46). The process reconstruction approach is frequently used by historical archaeologists such as Mark Leone (1972) and James Deetz (1977). This aspect of the cultural history approach is specifically interested in the instances of “cultural change” rather than periods of “cultural homogeneity” (Schlereth 1982:48).

Functionalist Approach

The functionalist approach to Material Culture Studies is rooted in the belief that culture is the result of people adapting to their environment and that any adaptations should be evident in the material record, especially with regard to technological artifacts (Schlereth 1982:53). Additionally, functionalists are interested not only in the artifact itself, but the maker’s mindset. The difference is emphasized between an object’s “use” (its primary purpose as was intended by its maker) and its “function” (a secondary or tertiary purpose not-so-obviously intended by its maker). This is similar to the symbolist theory distinction between “fact” and “symbol” but somewhat less subjective. Functionalists use all means at their disposal to determine an artifact’s use and infer its function. Methods include accessing historical documentation when available, and using experimental archaeology to simulate circumstances surrounding an object’s creation (Schlereth 1982).

Structuralist Approach

The structuralist approach to material culture holds that human-made objects represent a kind of language and can therefore be studied using theories and methodologies borrowed from linguistics. This approach tends to be preferred by folklorists, including Henry Glassie (1975), who used linguistics based models to study vernacular American architecture. Structuralists believe that artifacts have “functional roles” which relate to their primary usage, and “sign values” which collectively make up a communication system (Schlereth 1982:55). Identifying patterns and changes in patterns is considered a key element in decoding this communication system and is a primary concern of the structuralist (Glassie 1975:160). This approach is usually applied to studies involving a singular artifact type (rather than studies involving a variety of types) to better pinpoint very specific patterns. It has been argued, however, that even though it focuses on identifying changes in pattern, the structuralist approach to material culture falls short of analyzing causes of these pattern changes (Schlereth 1982:57). This may be why the structural approach is now considered "dead" by historical archaeologists (Leone 2012:3).

Behavioral/Poststructuralist Approach

The poststructuralist approach to Material Culture Studies (called the behavioral approach by Schlereth (1982)) grew out of the structuralist paradigm with which it shares some fundamental similarities. Both view material culture as a "language" that can be decoded and both are concerned with studying the makers of objects rather than the objects themselves (Olsen 2006:85). Poststructuralists tend to focus on a plurality of interpretations (artifacts' meanings to different people in different times and places) whereas structuralists focus on more singular interpretation (artifacts' meanings within original context to their original makers/users) (Olsen 2006:90). Uniqueness and the craftsman's creativity are central to poststructural material culture theory because poststructuralists believe in the great variability of culture and view it as an ever-changing phenomenon (Trigger 2006:467-469). Structuralists, on the other hand, believe there is more stasis in culture and, as previously mentioned, focus on identifying patterns in material culture rather than uniqueness in specific artifacts (Schlereth 1982).

Material Culture Theory and the QAR Aprons

The material culture theories described above are roughly chronological, but there is significant overlap, both in chronology and in definition. The theoretical approaches are by no means mutually exclusive and elements from each will be used to help shape the cannon apron study. A basic tenet that seems to permeate most material culture theory is that artifacts possess different levels of meaning, usually a conscious functional meaning and an unconscious symbolic meaning. This is evident in the distinction between "fact" and "symbol" in symbolism, "use" and "function" in functionalism, and "functional roles" and "sign values" in structuralism (Schlereth 1982:44,54-55). The QAR cannon aprons are objects with obvious primary functions (according to historical documentation) and ambiguous secondary functions (according to their surface markings), therefore a theoretical approach that accounts for different levels of meanings/functions should prove useful.

The symbolist approach is most often used for decorative arts, but may be relevant to the cannon apron study with regard to the surface markings. On one hand, the aprons represent the "fact" of their use with naval artillery; on the other hand, the surface markings reveal that they may also serve as the "symbol" of some aspect of the crew's mentality. It is important to be open to the possibility of symbolic meanings for the apron markings, but it is equally important to consider that some markings might not be manmade, and therefore have no symbolic or cultural meaning.

In order to keep from ascribing false meanings to the aprons, the more empirical cultural history and functionalist paradigms will be useful. Both theories emphasize historical research (whenever possible) and experimental methods in Material Culture Studies. Though sparse, primary and secondary historical documentation pertaining to cannon aprons does exist and it has been accessed for this study. Where there are gaps in the historical record, such as information on apron manufacturing methods, experimental archaeology will be used to complement the documents. This process is described in more detail in the Methodology Chapter.

Elements from both functionalism and structuralism involve seeking patterns and changes in patterns in material culture. Both approaches focus heavily on studying technological artifacts and what these artifacts say about changes in technology; both focus more on the maker of the object rather than the object itself. These elements will be incorporated in the theoretical grounding of the apron study. The QAR apron project is primarily directed at artifacts from one site, but it is meant to be the beginning of a larger, less particularistic study that compares aprons from many sites. Comparison is the means by which to identify patterns and/or changes in pattern and has become increasingly important in Material Culture Studies and Historical Archaeology (Camp 2012:13; Joseph 2012:1; Leone 2012:4). As Leone (2012:3) states "Big patterns of many things make historical archaeology a worthwhile endeavor." Since the identification of patterns in apron design and changes in naval artillery technology are goals of this project, the QAR aprons will be compared to one another and, briefly, to aprons from other archaeological sites. Comparative analysis will not be fully accomplished by this study because aprons from other sites have been investigated at a distance rather than in person, but the theoretical framework is present to continue the project in this direction.

Identifying patterns is one important aspect of the present study, but it is also important not to ignore the possibility that one or more of the QAR aprons may be unique amongst artifacts of their type. In this regard, the project's theoretical framework has been influenced by the post-structuralist approach to Material Culture Studies. Since post-structuralism focuses on "difference" and uniqueness of individual artifacts and individual craftsman, it may provide a useful basis for studying the apron markings (Olsen 2006:88; Trigger 2006:469). It is hypothesized that, while the aprons themselves may be standardized mass produced objects, their markings represent the unique work of individuals. If this is the case, a theoretical framework that supports both identification of patterns and identification of uniqueness is necessary.

It may seem contradictory to incorporate so many different theories into one study, even though they share some degree of overlap, but the QAR cannon apron project is meant to have as holistic an approach as possible. For many archaeological projects such a broad scope would be impractical, but the subject of the present study is a small assemblage, so having a broader scope is more manageable.

Behavioral Archaeology

Behavioral archaeology provides a model for analyzing "the relationships between human behavior and material culture in all times and places" (Schiffer 1995:69). It shares this basic tenet with processual archaeology, from which it evolved, but proposes a different approach. Processualists operate on the premise that the archaeological record is a *direct* link to past human behavior. This premise, sometimes referred to as the Pompeii premise, is best described by Lewis Binford's claim that "The loss, breakage, and abandonment of implements and facilities at different locations, where groups of variable structure performed different tasks, leaves a 'fossil' record of the actual operation of an extinct society" (Schiffer 1995:35). Behavioralists, on the other hand, see the archaeological record as an *indirect* and somewhat distorted link to past human behavior. Michael Schiffer disputes Binford's claim saying, "Between the time artifacts were manufactured and used in the past and the times these same objects are unearthed by the archaeologist, they have been subjected to a series of cultural and noncultural processes which have transformed them spatially, quantitatively, formally, and relationally" (Schiffer 1995:35). That is not to say that studying the archaeological record is useless, but rather that changes and distortions need to be identified and analyzed to more accurately explain the human behavior the archaeological record exhibits. The archaeological context of material remains may be distorted from the systemic, or living context, but behavioral archaeologists bridge the gap between them using what Schiffer (1995:35-45) calls a "synthetic model of archaeological inference" involving transforms and correlates.

Synthetic Model of Archaeological Inference

Correlates

Archaeology depends greatly on correlates to explain phenomena (Trigger 2006:426-427). The most frequently utilized are behavioral-spatial and behavioral-material correlates, the latter of which is more applicable to the present study. Behavioral-material correlates are laws that connect specific human behaviors with specific material remains. A correlate may state, for example, that a certain type of stone flakes in a certain shape when struck with a certain implement in a certain way. Therefore if stones with this shape (material remains) are discovered in a particular site, it may be inferred that they were created using the same implement with the same striking motion (human behavior). Conversely, if that certain implement and striking motion were believed to have been used at a particular site, archaeologists may expect to find stones of a certain shape there. The problem with relying solely on correlates is that material remains in their archaeological context are almost always distorted, if not removed, from their systemic context (Trigger 2006:426-427). The progression of an artifact from one context (systemic) to the other (archaeological) can be explained by processes called cultural transforms (c-transforms) and noncultural transforms (n-transforms) (Schiffer 1975, 1988, 1995; Trigger 2006).

C-Transforms and N-Transforms

Cultural transforms (c-transforms) are human-wrought processes that affect the depositional or post-depositional life of an artifact, as opposed to processes that affect pre-depositional use-life. In the early days of behavioral archaeology, c-transforms were defined primarily as the human behaviors by which artifacts enter the archaeological record. Such behaviors include abandonments, burial rituals, and de facto refuse (Schiffer 1995: 37). The definition of c-transforms has since been expanded to include not only how human behavior affects artifacts *as* they are deposited, but how it affects artifacts *after* they are deposited. By this expanded definition, plowing a field, salvaging a shipwreck, and looting a gravesite are c-transforms (Trigger 2006:426). The study of c-transforms is unique to archaeology but, according to Schiffer (1995:49), still underdeveloped. Recent projects on watercraft abandonments and ships' graveyards, however, have made great progress in recognizing the potential of c-transforms for landscape interpretations (Seeb 2007; Richards 2008; Smith 2010; Marcotte 2011).

Noncultural transforms (n-transforms) are natural processes that affect the post-depositional life of archaeological objects. These include environmental, biological, and chemical processes. Storms, scavenging animals, and corrosion are all examples of n-transforms. Unlike the study of c-transforms, the study of n-transforms (though not named as such) is not unique to archaeology. It is the purview of various other physical sciences and is therefore better developed and better understood than the study of c-transforms (Schiffer 1995:38). This does not mean, however, that archaeology has nothing to contribute to the study of n-transforms (Schiffer 1995:38). Certain data may be borrowed from other disciplines, but scientists in other disciplines do not apply this data to an archaeological context; only archaeologists do this. For example, meteorologists may study hurricane patterns in a given region, but only archaeologists might apply that data to the spatial distribution of artifacts in that region.

Life Processes of Durable Element

The synthetic model of archaeological inference is useful for explaining the processes that affect an artifact in its archaeological context, but not the processes that affect its systemic context. For a more organized analysis of the systemic context, Schiffer has broken down an artifact's use-life into five phases. These phases, which he names the "life processes of a durable element," include procurement, manufacture, use, maintenance, and discard (Schiffer 1995). There is a natural degree of overlap toward the end of the systemic and the beginning of the archaeological contexts (discard and deposition), and Schiffer (1995:27) notes not all artifacts follow the same progression; some may not even enter all five phases. The life process of a durable element is not meant as a rigid model but as a guideline for the study of an artifact's use-life.

Behavioral Archaeology and the QAR Cannon Aprons

A behavioral archaeology approach is often used to interpret cultural landscapes, such as landfills and ship graveyards, because it emphasizes the importance of site formation processes (Rathje 1974; Seeb 2007; Richards 2008; Smith 2010; Marcotte 2011). It is equally applicable to material culture studies like the QAR cannon apron project. Just as correlates, c-transforms, and n-transforms help describe the post-depositional processes that create a site, they can also describe the processes that affect artifacts within that site. One challenge in the cannon apron study is distinguishing between culturally significant markings and incidental markings. There are some incidental markings made during the aprons' systemic contexts and some that were made during the aprons' archaeological context. *All* culturally significant markings, however, should have been made during the systemic context. In distinguishing which marks were made in which context, progress is made toward one of the project's greater goals. The aprons have been distorted from their systemic context, but the synthetic model for archaeological inference provides an aid for eliminating this distortion.

C-transforms at work on the aprons include salvage and excavation, which will be analyzed briefly. Another c-transform to consider is the manner of their deposition. The *Queen Anne's Revenge* is believed to have been purposely scuttled; this type of abandonment constitutes a c-transform rather than an n-transform such as a storm or catastrophic event (Wilde-Ramsing 2009). Can archaeological analysis of the aprons confirm or deny this assertion? Is there evidence of defects that would explain the aprons' discard? Can the spatial distribution of aprons be related to their deposition process? Conservation treatments will also be considered c-transforms for the purposes of this study. Though perhaps not originally intended as a c-transform by the founders of behavioral archaeology, conservation treatments *are* human wrought processes that affect the post-depositional life of artifacts and must be considered a potentially distorting factor.

N-transforms considered in this study include corrosion of lead in seawater, concretion, and post-depositional distribution of artifacts. Lead corrosion types and their effects on surface metal are briefly discussed in Chapter 3 but are not considered in great detail because the QAR aprons are in a good state of preservation and show few signs of unstable corrosion products. Lead objects do not typically concrete in salt water, but the in situ proximity of some aprons to iron artifacts has caused this n-transform to be an issue that must be considered. Post-depositional distribution classifies as an n-transform in that it is heavily influenced by environmental factors.

The reconstructed systemic context will ideally include five processes that make up the life of a durable element: procurement, manufacture, use, maintenance, and discard (Schiffer 1972). It is important to note that the graffiti/markings on the aprons will not be considered c-transforms; they are part of the artifacts' pre-depositional life, probably associated with a secondary rather than a primary function, and will therefore be investigated as part of the systemic context using the processes of a durable element.

CHAPTER 3: METHODOLOGY

Introduction

The methodology used to conduct research for the present study can be separated into three categories: literature review, archaeological documentation, and conservation. Literature review is an essential first step in a research project because it establishes the nature and extent of previous work on the subject. The literature review for this study has three phases that correspond with methodological categories; for each phase there is discussion of research techniques used, gaps in the collective knowledge, and descriptions of useful sources. The archaeological methods section consists primarily of documentation, including creation of a standardized form (Appendix A), measurements, and terminology. The most detailed of the methodologies is the one pertaining to conservation. The conservation section discusses elemental analysis of the aprons, lead corrosion products, a step by step account of the treatment chosen for QAR 1321.000 and the reasons why that treatment was selected.

Literature Review

As one of the project's first steps, a literature review was conducted to establish background information and define the scope of the research. Literature was collected for each of the three methodological phases: history, archaeology, and conservation. The review determined the extent to which cannon aprons are referenced in primary source material, located archaeological examples of aprons from other sites, and helped formulate an appropriate treatment plan.

Historical Sources

A preliminary search for historical data yielded only cursory information about aprons, foreshadowing what would become one of this project's challenges. There is significant research on the development and history of cannon, but little research on their accessories. This may be due to the ubiquitous nature of cannon aprons on ships of the period, or it may be due to issues of terminology. To remedy the latter problem, the literature review was expanded to include information on the terms “touchhole covers,” “gun covers,” “vent covers,” and “vent aprons” as well as the original search term “cannon aprons.” The expanded terminology search turned up several secondary sources, as did more oblique research into the use of gunpowder, development of naval artillery, life at sea in the 17th and 18th centuries, lead manufacturing processes, and metalworking techniques. Among the most useful secondary sources were Blackmore’s (1976) *The Armouries of the Tower of London,* Caruana’s (1997) *History of English Sea Ordnance,* Lavery’s (1987) *The Arming and Fitting of English Ships of War 1600-1815,* and Boudriot’s (1986) *The Seventy-Four Gun Ship*. History journals were also consulted for secondary source material; the most frequently searched, to little avail, were *The Mariner’s Mirror* and *Journal of the Ordnance Society*.

Locating primary source material proved far more difficult than secondary source material. In some cases, it was possible to use secondary source bibliographies to locate primary documentation. In other cases this technique proved fruitless. Boudriot (1986:203), for example, included not a single reference, note, or citation regarding his research, but mentions in a postscript that writing the book required “hunting through a mass of archival material.” Library reference guides and digital bibliographies were especially helpful in locating primary source material. The National Maritime Museum Research Guide B10 on Naval Gunnery (http://www.nmm.ac.uk/researchers/library/research-guides) proved invaluable as did The Maritime History Virtual Archives Bibliography on 18th Century Naval Gunnery (http://www.bruzelius.info/Nautica/Bibliography/Gunnery(18th).html). The most useful primary sources were artillery treatises and gunner's manuals such as Binning's (1677) *A Light to the Art of Gunnery*, Moretti's (1673) *A General Treatise of Artillery*, Muller's (1780) *A Treatise of Artillery*, and Seller's (1691) *The Sea Gunner*. These sources were useful in confirming the primary function of cannon aprons described in secondary sources; the information, however, was usually brief and without detail. The treatises and manuals offered short descriptions of how and why aprons were used but neglect to mention where they were manufactured, when they were first used, and whether or not they were used for other purposes. Other primary source material included ships' stores inventories, court proceedings, and naval provisioning records. These sources were useful in determining the quantities of aprons kept onboard, but, like other primary sources, were not helpful in determining whether or not the aprons had a secondary function.

A small portion of the research presented here focuses on the history of *Queen Anne's Revenge* during its service as a French privateer, a slaver, and as Blackbeard's flagship. This history helped establish background information relevant to the apron study including vessel time period, nature of armament, and descriptions of the wrecking event. Primary sources accessed for this history include Jacques Ducoin's (2001) archival research on *La Concorde* compiled in Nantes, France, depositions by Francois Ernaut (1718) and Pierre Dosset (1718) (former lieutenant and captain of *La Concorde*), the South Carolina Court of Vice Admiralty (1719) records of Stede Bonnet's trial, and the works of contemporary writer Captain Charles Johnson (1724, 1728), now believed to be Daniel Defoe. This research was supplemented with information from Wilde-Ramsing's (2009) dissertation, Steady As She Goes: A Test of the Gibbs' Model Using the *Queen Anne's Revenge* Shipwreck Site, which accessed many of the same primary sources.

Archaeological Sources

In addition to historical documentation, the literature review included site reports (of which few were found) from shipwrecks where cannon aprons were known to have been recovered. Due to a lack of published material, this study relied heavily upon personal communication with ordnance experts, archaeologists, and curators who have worked with aprons. Reviewing this data helped establish the nature and extent of previous archaeological work on cannon aprons. The QAR database and report series were accessed most frequently, and Wilde-Ramsings (2009) dissertation was used to establish the previous archaeological work on the QAR site. Other sites where aprons were recovered are the Alderney Wreck, the Scallastle Bay Site, *Whydah*, *Dartmouth*, *Invincible*, *Pomone*, and *De Braak* (Alderney Maritime Trust nd; McBride 1976; Hamilton 1992; Kaye 1998; Maddocks 2007; Bingeman 2010; Charles Fithian 2011, pers. comm.). The Scallastle Bay Site was particularly interesting because an online report noted that an apron recovered in 1998 was "scratched and dented, with some adhering concretion and marine life, but bears no apparent graffiti" (Kaye 1998). The description implied that there are other recovered aprons that *do* bear "apparent graffiti." This phrase could refer to aprons from the QAR and other sites. Archaeological journals and conference proceedings were also accessed, most frequently the *International Journal of Nautical Archaeology* and *Historical Archaeology*. The archaeological literature on cannon aprons is almost as sparse as the historical literature, but it yielded useful information with regard to longevity of use (based on the date of the Alderney Wreck) and various apron forms (based on differences between aprons from the other seven sites).

Just as interesting as what it *did* yield is what the archaeological literature did *not* yield. Overall, the archaeological literature review revealed a paucity of reports mentioning cannon aprons. Based on stores inventories, this should not be the case; ships often carried enough aprons to have one for each gun and some spares (Povey 1702). This suggests that perhaps cannon aprons from other shipwreck sites have been misidentified, or remained unidentified as of yet. To test this hypothesis, several archaeological reports referencing lead patches or sheathing were included in the archaeological literature review as well. Interestingly, this search located two possibilities of misidentified aprons. The first is an artifact recovered during a Minerals Management Service investigation of a ballast pile off the Chandeleur Islands, Louisiana. The object (Figure 2) is described as "an almost square (19.8 cm x 17.8 cm x 0.31 cm) sheet lead patch with two round fastener holes….The fasteners were driven through the top of a rounded ridge which flattens out and then rises again as if to fit up against an edge. It is evident that the patch has retained the shape of the object to which it was attached" (Garrison et al. 1989:7-11). The second possible apron (Figure 3) was recovered during an Odyssey Marine Explorations project in the western English Channel. The object is described as a 20 cm by 18 cm by 0.5 cm "lead patch fragment...with two nail holes visible on the outer edge" (Dobson 2010:26). Both artifacts are identified as lead patches, and both bear striking similarities to the QAR cannon aprons.

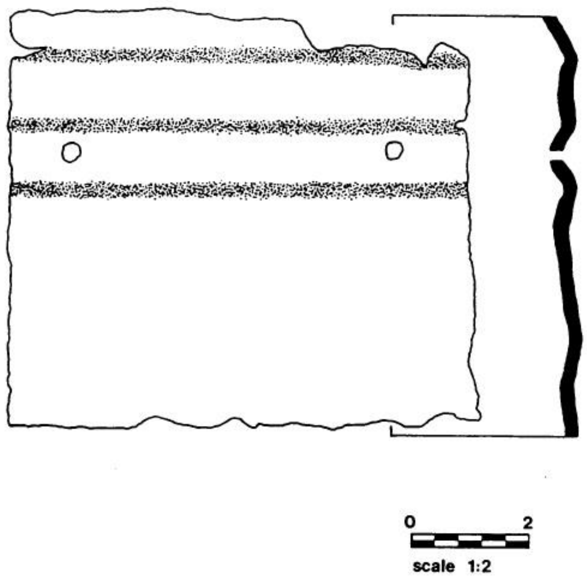


FIGURE 2. Possible apron from the Chandeleur Ballast Pile (Garrison et al. 1989:7-13).

FIGURE 3. Possible apron from the western English Channel (Dobson 2010:26).

Conservation Sources

The third phase of the literature review was an examination of archaeological conservation journals and conference proceedings. These sources were used to establish a history and basic understanding of treatments for lead artifacts from marine environments. Lead corrosion products, particularly cerussite and hydrocerussite, were researched for their impact on the surface of leaden objects. Publications were accessed from the United Kingdom Institute for Conservation, the International Institute for Conservation, and the American Institute for Conservation. Articles from *Lead and Tin: Studies in Conservation and Technology* were helpful, particularly Turgoose's (1985) The Corrosion of Lead and Tin: Before and After Excavation, Pollard's (1985) Investigations of 'Lead' Objects Using XRF, and Watson's (1985) Conservation of Lead and Lead Alloys Using E.D.T.A. Solutions. Techniques for preserving lead artifacts were pioneered at the British Museum, so the literature review also included sources written by British Museum conservators, such as Watkins's and Dove's (2002)

Reversing Corrosion: A Review of Consolidative Electrolytic Reduction Treatments of Corrosion on Lead Artefacts, and Green's (1989) A Re-evaluation of Lead Conservation Techniques at the British Museum. Ultimately, information obtained from conservation literature laid the groundwork for the treatment plan for the last QAR cannon apron remaining in concretion. A summary of this data can be found in the Conservation Methods section of the present chapter.

Archaeological Methods

Most of the archaeological methods used in this study can be classified as documentation, in one form or another. Other methods often used in material culture studies (such as statistical analysis) are largely useless here due to the assemblage's small size and the small number of cannon aprons known to exist in the archaeological record. The most important data in this case comes from direct study of the artifacts themselves. Basic information about each apron, including rough dimensions and weights, already existed in the QAR Conservation Lab database. This information was accessed for the present study and supplemented with data from more detailed investigations, described below.

Template

The initial step in documenting the QAR cannon aprons was creating a standardized template to record their physical attributes. It was believed that, since the QAR aprons all share a same basic form, they could be recorded with the same basic template. This proved easier said than done, but was accomplished after several drafts with input from QAR and NC UAB staff; the form will eventually become part of the state's artifact database. The template (Appendix A) consists of two parts. Part I was designed to collect quantitative data including dimensions, thicknesses, number of "fingers" and fastener holes. Part II was designed for a more qualitative analysis, including descriptions of patinas, corrosion products, damage, and/or markings. Since one goal of this project was to help researchers identify aprons from other sites, templates were made so they could be easily modified for use with other assemblages.

Orientation

The first step in creating the template was figuring out how to designate between the aprons' obverse and reverse sides. Accurate measurements hinged directly on having the object's correct orientation, but the aprons have no shared characteristic that can be used to dictate this orientation. To remedy this issue, the obverse and reverse sides of each apron were arbitrarily assigned and photographs of each, labeled Face A and Face B, were included on the first page of the template (Figure 4a). Schematic drawings were also included with labels of the various apron components (sides, fastener holes, fingers, and finger sides) (Figure 4b). To further clarify correct orientation, instructions were printed under each schematic describing how the components were numbered. Template Part I consists of sections for each component where dimensions and notes can be recorded. These sections were created with the hope that they could later be used to determine a method of manufacture for the aprons.

FIGURE 4a. QAR 1513.000 Face A (Photo courtesy of NCDCR).

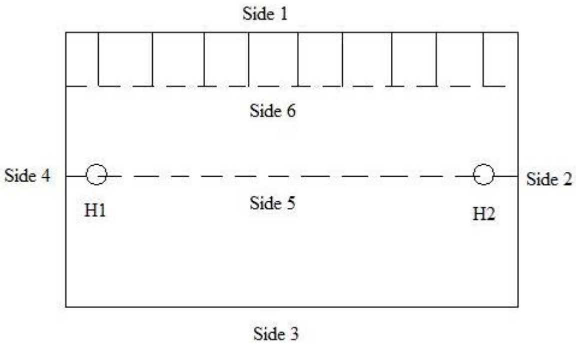


FIGURE 4b. Face A apron schematic (Drawing by author, 2010).

Sides

The term “sides” refers to the four edges that compose the aprons’ rectangular shape when seen in plan view. On Face A, Side 1 is the top edge (where the fingers, if any, are located) and Sides 2, 3, and 4 follow sequentially in a clockwise direction. Arbitrary sides in line with the fastener holes and at the base of the fingers (Sides 5 and 6) were assigned to help establish the artifacts’ average widths. This template section includes a space to record each side’s lengths and cross-sectional shapes. All lengths were measured in millimeters and a flexible tape was used to accurately follow bends and folds in the aprons. The cross-sectional shapes of the sides’ edges were identified as either unifacial, bifacial, rounded, or unknown (Figure 5).

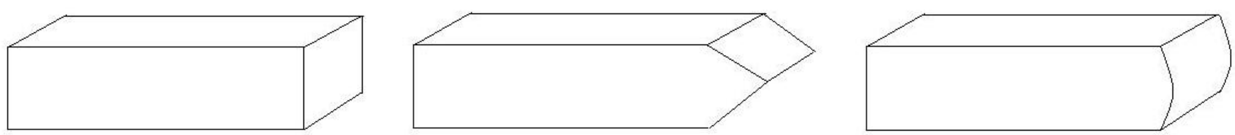


FIGURE 5. Schematic showing unifacial, bifacial, and rounded cross-sectional edges (Drawing by author, 2011).

Fingers

Fingers are the tabs created by slits in the apron (usually in side 1). The number of fingers varies, but no apron has more than nine fingers on one side. On Face A, the finger in the top left corner is F1 with F2-F9 following sequentially to the right. Some aprons have gaps or missing fingers that are recorded in sequential order with the existing ones, but designated by the letter “M.” Two fingers followed by an empty space, for example, would be designated as F1, F2, and MF3. The sides of the fingers are labeled as well. On Face A, F1a is the top edge of the finger in the top left corner, and F1b, F1c, and F1d follow sequentially in a clockwise direction (Figure 6). This section of the template includes space to record the number of missing fingers, the number of existing fingers, lengths, widths, and cross-sectional shapes of each finger’s sides.

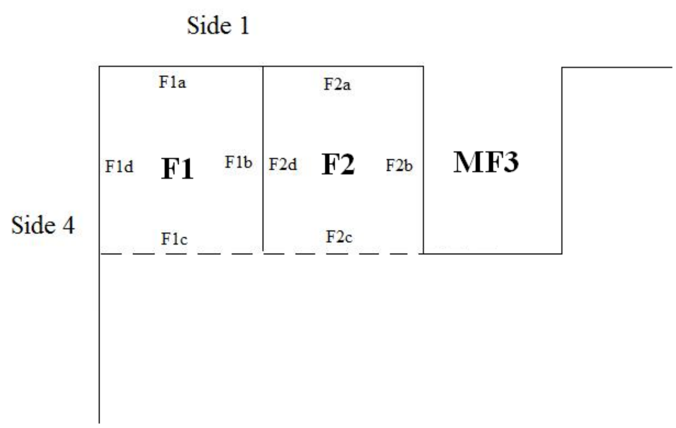


FIGURE 6. Apron fingers schematic (Drawing by author, 2010).

Fastener Holes

Most aprons have two fastener holes, one on the left and one on the right. On Face A, H1 is the fastener hole on the left side of the apron, near side 4, and H2 is on the right, near side 2. This section of the template has a place to record the number, shape, and size of the holes. It also has a place for the cross-sectional shape of the edge of the holes, the distance between H1 and H2, and whether or not excess lead has sloughed away from the holes onto either Face A or Face B. A space has been left available for additional notes, if any.

Thicknesses

Thickness has a dedicated section in template Part I because it was originally thought that measuring lead thickness in various places might help determine an apron's method of manufacture. Ultimately, it proved a frustrating and inaccurate process. The first difficulty was in trying to record exactly where on the surface the thickness was measured. The solution for this problem was to draw a grid over the apron image and note the location of the thickness measurement using an (x,y) coordinates system. This is described in greater detail in the section on template Part II. The next problem was recording thicknesses near the aprons' centers. The self-reading dial calipers were too short to reach the center, so spring calipers with no attached measuring device were used. This only worked, however, for aprons on which the center was thicker than the outer edges. Otherwise the spring calipers had to be twisted open so as not to damage the surface of the artifact and the measurement was lost.

Template Part II

The second part of the template is designed to record qualitative data about markings, patinas, and corrosion. These components are where the aprons have the most variation from each other, so it is the least standardized part of the form. It consists simply of a black and white image of the artifact with an overlaying grid and an entire blank page for notes. The black and white images were created using Adobe Photoshop 7.0 to mimic archaeological line drawings in a fraction of the time it would take to illustrate the objects by hand. Vertical and horizontal scales were added and the grid overlaid with lines corresponding to every third centimeter. Using an (x,y) coordinate system where (0,0) is in the bottom left corner, this grid allows for the precise recording of each marking's location. This system used the same image from the thickness section, but enlarged so markings could be included.

Experimental Archaeology

The apron template was designed to help determine (among other things) a method of manufacture. Part I, for example, prompts investigation of the edges of the apron fingers and requires a researcher to choose whether an edge is rounded (as if cast), unifacial (as if cut with a hammer and chisel), or bifacial (as if cut with shears). The template assumes there is a difference between cuts from shears and cuts from a hammer and chisel. Since there has been little or no previous research on tool marks in lead, this project required some experimental archaeology. Lead sheets of approximately the same thicknesses of the cannon aprons were cut, punched, scratched, etc. with a variety of tools. The tools marks were then examined and compared to apron marks. Microscopy was used to examine the cross-sections of some of the scratch marks and engravings. Unfortunately only the cross-sectional shapes were definitive enough to use for interpretation.

Conservation Methods

In the most general sense, conservation is the collective processes by which cultural property is stabilized and preserved. The three main goals of conservation are to ensure durability of specific objects, respect the integrity of those objects, and offer accessibility to the objects (Berducou 1996:250). The first goal, ensuring durability, pertains to taking measures that will prolong an object's existence. The second goal, respecting the integrity of the object, dictates that stabilization methods "must in no way affect the nature of this property, neither its material constituents nor the meaning or meanings those materials convey" (Berducou 1996:250). This goal requires conservators to be well informed about the objects they treat. Conservators should know, for example, the material from which an object is made, the physical and chemical properties of that material, and the cultural significance of an object, so that neither the material nor the meaning is compromised in treatment. The third goal of conservation, offering accessibility, is the culmination of the two previous goals; the purpose for prolonging the existence and respecting the integrity of cultural property is so that it can be studied, catalogued, visited, etc. by future researchers and the general public (Berducou 1996:250).

With these goals in mind, a conservation plan was formulated for the untreated apron in wet storage. Research was conducted to determine the apron's material type, properties, and common corrosion products. The exact cultural significance of the aprons was unknown, but surface markings were considered an integral part of this significance. Treatment options were chosen with the intent of stabilizing the apron, retaining the integrity of the material and culturally significant markings, and allowing accessibility for future research and/or display.

Elemental Analysis and Lead Properties

X-ray fluorescence (XRF) is frequently used by archaeologists and conservators to determine objects' elemental composition. XRF analysis is fast, nondestructive, and provides semi-quantitative data for a variety of materials including metals, metal alloys, ceramics, pigments, and glazes (Pollard et al. 2007:118). In 2009, conservators at the QAR Lab had temporary access to a portable XRF spectrometer which they used to analyze several aprons (Appendix B). The untreated apron, QAR 1321.001 was not analyzed but appears to be composed of the same material. XRF data confirmed that aprons 0002.000, 1497.000, and 1513.000 are made of almost pure lead with trace elements (less than 1%) of iron and copper. Its main limitation is that XRF can only analyze surface layers; metal corrosion products and "surface inhomogeneity" can skew the data, but XRF is still useful for determining the presence or absence of elements (Pollard et al. 2007:118). In order to avoid these problems, multiple readings were taken on both faces of the aprons; the results were nearly identical in all cases suggesting that the aprons are made of pure lead.

Lead is a soft non-magnetic metal with a low melting point (327° C) and a high boiling point (1749° C) (Selwyn 2004:115). It is generally resistant to active corrosion because most lead corrosion products are insoluble and create a semi-passivating protective layer over the surface. The exception to this rule is that lead corrosion products are soluble in acidic and alkaline solutions because lead is an amphoteric metal (Selwyn 2004:119). Lead will suffer active corrosion in environments with a pH less than 5 and greater than 10; this point is especially relevant with regard to wet storage options for the untreated apron, which will be discussed later (Selwyn 2004:119).

Lead Corrosion Products

Lead tends to be a fairly stable metal, and leaden archaeological objects typically have a high resistance to deterioration in many burial environments. The semi-passivating layer created by most lead corrosion products helps keep metal ions in and oxygen out (Turgoose 1985:21; Green 1989:121; Watkins and Dove 2002:23; Schotte and Adriaens 2006:1). There are some environments, however, in which this protective layer cannot keep the metal from deteriorating. Stable corrosion compounds that form the passivating layer are soluble in organic acids, so lead in an acidic environment will suffer from active corrosion (Turgoose 1985:21; Green 1989:121; Watkins and Dove 2002:23; Schotte and Adriaens 2006:1).

One common lead corrosion compound is cerussite ($PbCO_3$), or lead carbonate. Cerussite is a stable compound that forms on lead in aerobic alkaline conditions such as loose soil or marine environments (Watkins and Dove 2002:23). These environments have high partial pressures of carbon dioxide, which provide carbonate anions necessary for forming cerussite (Turgoose 1985:21). This layer usually appears as a white or light gray crust over the surface of a leaden object (MacLeod 1991:231). Since cerussite is a stable, compact corrosion product that is insoluble in many environments, it can help preserve lead surface markings (Watkins-Kenney 2011, pers. comm.).

Another common lead corrosion compound is hydrocerussite ($Pb_3(OH)_2(CO_3)_2$), or basic lead carbonate. The presence of hydrocerussite on an artifact is problematic because it is an unstable compound and is an indicator of active corrosion. If this compound is left in situ on an object, the entire artifact will eventually deteriorate (Green 1989:121). Hydrocerussite also needs carbonate anions to form, but at lower partial pressures than cerussite (Turgoose 1985:21). Air has a low partial pressure of carbon dioxide, as does tap water; therefore newly excavated lead objects that had been stable in their burial environment may develop blooms of hydrocerussite if/when they are exposed to the air or tap water (Turgoose 1985:21). Hydrocerussite can also form on previously stable lead objects if they are stored in an acidic or alkaline environment. Unlike cerussite, which is a compact corrosion product, hydrocerussite is voluminous and usually appears as a white, powdery film instead of a crust (Selwyn 2004:120).

Several other common lead corrosion products are galena, litharge, and massicot. Galena, or lead sulfide (PbS), more commonly known as lead ore, is also a stable lead corrosion compound. Galena forms on lead objects in anaerobic environments where sulphate reducing bacteria are present (Watkins and Dove 2002:23). Galena is the *only* lead corrosion compound that forms in anaerobic conditions (MacLeod 1991:232). It appears as a matte gray or black patina on an artifact (Watkins and Dove 2002:23). Litharge and massicot (PbO) are both stable lead monoxides that form in aerobic alkaline environments where there are few carbonates present (Watkins and Dove 2002:23). Litharge appears as a reddish brown crust on the surface on the lead and massicot appears as a yellowish brown crust.

Lead objects in seawater are typically protected from active corrosion because the aerobic salty environment forms an insoluble layer of lead sulphates and chlorides (Robinson 1998:64; Selwyn 2004:122). Lead sulphate is a stable corrosion product and therefore lead artifacts recovered from marine burial environments do not usually require the intense desalination processes other metal objects must undergo (Selwyn 2004:119). Concretions can form around lead artifacts in seawater if the objects are in close proximity to iron; QAR 1321.001, for example, was recovered as part of a concretion containing a cannon ball and a cluster of nails.

Lead corrosion compounds are often identified visually, based on color and form, and with analytical methods including x-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier-Transform infrared spectroscopy (FTIR) (Turgoose 1985:15; MacLeod 1991:222-223; Robinson 1998:51). XRD and FTIR require samples of concretions or corrosion products to produce a quantitative analysis of the minerals present. SEM is used primarily for qualitative analysis comparing images of unknown samples to images of known compounds, but it can be used for quantitative results when paired with an analytical unit (SEM-EDX) (MacLeod 1991:223; Pollard et al. 2007:119). One problem with using techniques such as XRD and FTIR is that the sample must be dry, which can cause crystallization of dissolved solids or trigger new chemical reactions in the compounds to be analyzed. This would make the results accurate for the artifact's current environment, but not necessarily for its burial environment (Turgoose 1985:15).

Treatment

Twelve of the 13 aprons examined for this study had already been conserved but one was in wet storage awaiting treatment. The one untreated artifact in the assemblage provided a unique opportunity to study not only the objects themselves, but the exact processes they went through from site to museum. For this study, conservation treatments are considered c-transforms. Assisting conservators in the treatment process therefore provided first hand information about the effects of this transform and helped connect the aprons' systemic context to their archaeological context.

The untreated apron was part of a concretion designated QAR 1321.000. After recovery, it was photographed, accessioned, and placed in an aqueous solution of 2.5% sodium carbonate. Lead and pewter artifacts from the QAR site are not typically stored in sodium carbonate because it is an alkaline solution and, as previously described, can cause active corrosion. The preferred wet storage option for lead at the QAR Lab is a 700 ppm sodium sulphate solution because lead forms a protective corrosion layer in the presence of sulphate salts (Robinson 1998:64). The untreated apron, however, was attached to a concretion containing iron artifacts, which needed to be stored in an alkaline solution to prevent active iron corrosion. A treatment plan was devised that would allow the apron to be stabilized, cleaned, and prepared for research and exhibition without jeopardizing the integrity of possible surface markings. In the end, the actual treatment involved cleaning with both mechanical methods, such as pneumatic tools, and chemical methods, such as hydrochloric acid, but several different options were considered before this plan was selected.

Lead Treatment Options

Many lead corrosion compounds form a semi-passivating layer around the metal helping keep deterioration at bay. While this layer is beneficial in terms of preservation, it can be a liability in terms of historical and archaeological interpretation because the corrosion may obscure surface detail. Consolidative electrolytic reduction (CER) is a conservation technique used to help alleviate this problem by converting active lead corrosion compounds, usually hydrocerussite, back to original metal while preserving existing surface detail (Watkins and Dove 2002:24). CER is set up in much the same fashion as regular electrolytic reduction but uses far lower amperage. The decreased amperage in turn decreases hydrogen evolution. Hydrogen bubbles are useful for cleaning some metals but could destroy the delicate surface on lead objects (Watkins and Dove 2002:24). The goal of CER is not to clean corrosion off artifacts but to reduce the corrosion layer back to lead.

Though CER has been successful in preserving surface detail in lead objects, there are those who caution against its use (Cronyn 1990:208; Watkins and Dove 2002:24,29). CER is a non-reversible treatment that alters the chemical composition of the artifact's outer layer. This change could negatively affect future research using methods like XRF and isotope analysis (Cronyn 1990:208; Watkins and Dove 2002:29). Other treatments for removing corrosion from lead objects sometimes involve stripping to the metal and therefore entirely losing original surface detail. These treatments include brushing the surface with hydrochloric acid, immersing the object in an ion exchange resin, and chelation baths of ethylenediaminetetraacetic acid (EDTA) (Watson 1985:44). Hydrochloric acid has proven extremely efficient in dissolving lead carbonate compounds but it will also dissolve non-corroded metal (Schotte and Adriaens 2006:2). Ion exchange resins such as Amberlite IR 120 are gentler on lead but have not been proven to remove corrosion compounds other than lead carbonate. An economic advantage of using ion exchange resins is that the resins can be regenerated and reused (Schotte and Adriaens 2006:3). EDTA is effective for removing most, but not all, stable lead corrosion compounds (Watson 1985:44). Since EDTA is an organic acid it will also dissolve bare metal, adding a new problem (Watson 1985:44; Schotte and Adriaens 2006:3).

None of the treatments mentioned, including CER, will prevent future corrosion if a lead object is placed in an unstable environment (Watkins and Dove 2002:28; Schotte and Adriaens 2006:6). For this reason coatings are sometimes applied to keep an object safe from potentially harmful conditions such as humidity and organic acids. An evaluation of previously treated lead artifacts in the British Museum, however, has shown that coatings are not consistently useful for this purpose (Green 1989:125-130).

Treatment Proposal and Methods

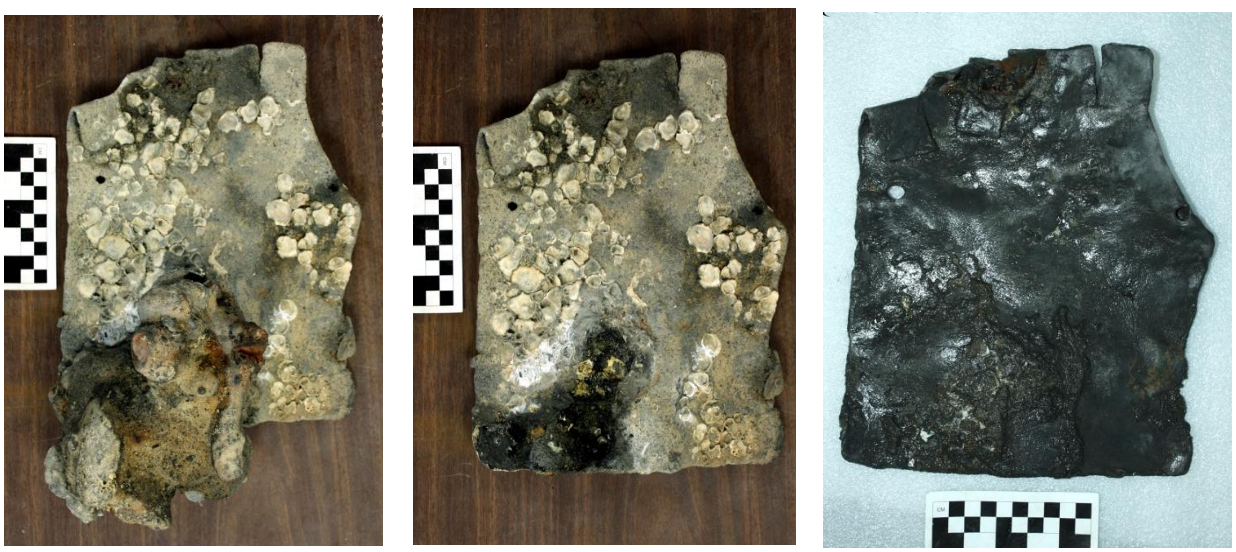
Choosing a treatment option for lead artifacts depends on the artifact's condition and the type of information it is expected to yield. If there is active or obscuring corrosion, or decorations and surface markings that require archaeological interpretation, consolidative electrolytic reduction with little to no hydrogen evolution is the best option. If there is no detail in the lead surface and XRF data or isotope analysis is desired at some point, an acid bath may be a better treatment option. Many of the previously treated QAR aprons do have surface markings, so it was likely that QAR 1321.000 would as well. While research indicates that CER might have been a suitable treatment for this apron, XRF data may be desired at a later date. Also, even though CER has been proven an effective treatment for *corroded* lead artifacts, it has not necessarily been proven effective for *concreted* lead artifacts. Since a large portion of QAR 1321.000's surface (Figure 7a) was covered with oyster shells and rock-like concretion that would likely be too stubborn to be removed with a gentle process like CER, it was decided to use a combination of mechanical and chemical treatment methods.

QAR 1321.000 was recovered on November 6, 2006. It was accessioned, photographed, stored in tap water, and then delivered to the lab several days later. In June 2007, the concretion was placed in an aqueous solution of 2.5% sodium carbonate to inhibit further corrosion during wet storage. Between March 2009 and January 2011, the apron was part of two traveling exhibits, during which it was presumably stored in sodium carbonate. Upon return to the lab, it was noted that part of the concretion had broken away from the apron, but neither piece seemed damaged. Both pieces of the concretion were x-rayed in March 2011 using 130 KV and 15 mA for a 30 second exposure. In addition to the cannon apron, the x-ray image of QAR 1321.000

revealed clusters of Rupert method lead shot, an iron nail, and an unidentified object, none of which appeared compromised by the break.

The first step in treatment was separating the apron from the concretion using an air scribe, hammer, and chisel. The x-ray served as a guide for this process and showed which areas of concretion held fewer artifacts and were therefore less likely to be damaged during separation. Using the air scribe, a seam was created around the concretion's base, approximately 0.25 inch from the apron's face. Eventually, when the seam became too deep for the air scribe to reach, a chisel was inserted between the apron and the concretion; a few quick taps with a hammer completed the separation (Figure 7b). At this point, QAR 1321.000 consisted of three pieces: the concretion that broke off prior to x-ray, the concretion removed by air scribe, and the cannon apron. All three objects were photo documented using a Canon Rebel XSI. Debitage from the air scribing process was collected, labeled, and stored in a plastic bag for potential later analysis. The two pieces of concretion QAR1321.000 were placed back in the aqueous solution of 2.5% sodium carbonate. The lead apron was assigned a new artifact number (QAR 1321.001) and placed in an aqueous solution of 700 ppm sodium sulfate for wet storage.

The next treatment step was immersing the apron in a bath of 10% hydrochloric acid in reverse osmosis water. The solution bubbled vigorously after initial immersion but activity slowed over time. The apron was removed from the acid approximately every 15 minutes and the surface gently scrubbed with a soft bristle toothbrush to help break up adhering shells and concretion. Photographs were taken at various intervals to document the concretion removal. After approximately 60 minutes, the acid solution turned a dark gray color and stopped bubbling. At this point the apron was switched to a bath of fresh 10% hydrochloric acid, whereupon bubbling resumed. The apron remained in the second bath for about another 60 minutes, after which it was rinsed in a solution of 700 ppm sodium sulfate to neutralize the acid. Tap water and reverse osmosis water should not be used to rinse lead artifacts because, as previously mentioned, they can cause the formation of hydrocerussite blooms (Turgoose 1985:21). During the rinse, the surface of the apron was gently scrubbed with a soft bristle toothbrush. The rinse created a matte gray patina on the apron's surface, most likely the stable lead sulfide corrosion product (Figure 7c). More photographs were taken and the apron was allowed to air dry on a shelf for several days.



A B C

FIGURE 7. QAR 1321.001during treatment: *(a)* before concretion removal; *(b)* after concretion removal; *(c)* after acid bath (Photos by author, 2011).

It was hoped that chemical cleaning methods would remove most surface obscuring debris so potentially damaging mechanical cleaning methods would not be necessary. Unfortunately this was not the case. The acid baths dissolved nearly all oyster shell on the apron's surface, but left behind large patches of tough concretion. The next step in cleaning the artifact was to remove the concretion patches using pneumatic tools. Pneumatic tools are not generally a preferred cleaning method for lead because they require air pressures high enough to gouge the metal if they get too close to the artifact's surface. In this case, however, the concretion was too hard to be removed with gentler mechanical means such as scalpels, dental picks, or bamboo sticks.

A Chicago Pneumatics CP9361 and a finer tipped Aro Corporation 8315 were both used. Extreme care was taken to angle the scribe tips so that they were not perpendicular to the apron's surface; this helped ensure concretion particles were chipped away from the metal rather than embedded in its surface. Pneumatic tools were successful in removing some concretion, but the apron's surface was nicked a few times despite the cautious use. Photographs were taken after treatment, including detailed shots of the affected areas. Air scribe damage was minute, but was documented for comparison with markings on other aprons. Damaging an artifact is not good practice, but in this case at least provided some insight. This evidence, in conjunction with evidence from the experimental archaeology, made it possible to rule out some markings on other aprons as graffiti based on similarities to known air scribe damage.

After the mechanical cleaning, the apron was re-immersed in a 10% hydrochloric acid bath for approximately 60 minutes. There was little to no bubbling and very little concretion was removed. This may be due to the fact that the acid was reused from the previous bath; a fresh solution may have yielded better results. As before, the apron was then rinsed in 700 ppm sodium sulfate, brushed with a soft bristle toothbrush, photographed, and allowed to air dry on a shelf.

The process of alternating mechanical and chemical cleaning methods was effective but gradual. The next treatment steps combined the two methods for a more efficient use of time. A fresh solution of 10% hydrochloric acid was applied with an eye dropper as a spot treatment for certain concretion areas. The acid was allowed to sit for 10-15 minutes while concretion at a different point was cleaned with an air scribe. To keep from further damaging the metal surface, the Aro scribe was used under a Fisher Scientific binocular microscope set at 3.0 times magnification. This allowed for highly detailed work and more precise strokes. After 15 minutes, the spot treated area was rinsed with 700 ppm sodium sulfate and then cleaned with the Aro while another area of concretion was undergoing acid spot treatment. This process continued for several hours, rotating the three most heavily concreted areas, one on Face A, one on Face B, and one between the fingers. At the end of the process, the apron was photographed, including detailed images of the three spot treated areas, and allowed to air dry on a shelf.

This last step was repeated twice. By this time the concretion layer had become very thin. Poultices of 10% hydrochloric acid on Kimwipes were applied to the concreted areas and then air scribed under the microscope again. This process was continued until the concretion layer was so thin that further mechanical cleaning would damage the apron’s surface. At this point QAR conservators took over the object’s treatment.

CHAPTER 4: HISTORY OF THE VESSEL

The following chapter presents the results of the literature review on the history of the vessel. Establishing this background is relevant to the apron project because "The conversion and operation of *La Concorde* as the pirate flagship *Queen Anne's Revenge* was the primary contributor in forming the nature and content of physical evidence carried aboard the ship as it approached Beaufort Inlet" (Wilde-Ramsing 2009:115). As an examination of this "physical evidence," it is important for the present study to include a brief summary of the ship's history, as both *La Concorde* and *Queen Anne's Revenge*.

La Concorde

The origins of *La Concorde* are mysterious. The vessel first appears in the historical record in 1710 as a French privateer owned by Rene Montaudoin (Ducoin 2001:93; Wilde-Ramsing 2009). Historians are unsure how the ship came to be in Montaudoin's possession, but speculate on three different scenarios. It was possibly a decommissioned French naval vessel, a Dutch prize captured in Queen Anne's War, or a locally constructed merchant vessel (Ducoin 2001). Unfortunately there are no naval records, war prize registers, or shipbuilding receipts to confirm any of these options (Wilde-Ramsing 2009).

As previously mentioned, *La Concorde's* first known operations were as a French privateer starting in July 1710. For about a year and a half it patrolled waters off western Africa and in the Caribbean, capturing Dutch, Portuguese, and English ships (Le Roux 1711). It is described during this period as a 300 ton frigate armed with 26 cannon (Le Roux 1711; Wilde-Ramsing 2009:111). This information most closely categorizes the vessel as a "light frigate," a three masted ship under 100 feet long with a 28 foot beam and armed with 25-30 cannon (Boudriot and Bertia 1993:52-54; Wilde-Ramsing 2009:110-111).

Almost immediately after the 1713 Treaty of Utrecht ended Queen Anne's War, Montaudoin converted *La Concorde* for use as a slaver. This type of conversion was not uncommon since both privateers and slave ships were required to balance "size, speed, power, and crew" and the end of the war left many privateers idle (Wilde-Ramsing 2009:109). Little is known of the changes made to *La Concorde* for its new career except that its armament was reduced from 26 to either 14 or 16 guns (Dosset 1718; Ernaut 1718). Other likely changes include construction of shelving between decks to maximize capacity for slaves (Wilde-Ramsing 2009:113). Between 1713 and 1717, *La Concorde* completed two full voyages as a slaver. The third voyage was interrupted; it was captured by two pirate ships captained by Benjamin Hornigold and Edward Teach (Dosset 1718; Ernaut 1718).

La Concorde embarked on its third voyage from Nantes on 24 March, 1717 (Ernaut 1718). On 6 June the ship arrived off the west African coast at Mesurade (in modern day Liberia) and from there made its way to the port of Judas. While in Judas, the crew of *La Concorde* "did the slave trade and loaded on the said ship the number of 516 heads of blacks of all sexes and ages and 14 ounces of gold in powder" (Ernaut 1718). On 2 October, the vessel left Africa and headed to Martinique, where the slaves were to be sold. Less than 40 leagues from its destination, *La Concorde* was set upon by two pirate sloops. According to Lieutenant Ernaud's (1718) deposition, one sloop was armed with 12 cannon and 120 men; the other carried 8 cannon and 30 men. While *La Concorde* was also armed, more than half its crewmembers were sick with scurvy and dysentery. Only 31 men were well enough to fight, so Captain Dosset decided the odds were too unfavorable and surrendered without resistance (Ernaut 1718).

After the surrender, the pirates escorted *La Concorde* to the nearby small island of Bequia where they seized most of the non-human cargo, the gold dust, and the crew's personal belongings. The pirates also kept the ship "with all its cannons and tackle" and forced ten of *La Concorde's* men to join them, amongst them a pilot, carpenter, and two surgeons (Ernaut 1718). Four others joined of free will. The pirates sailed away, but left their smaller sloop for the men stranded on Bequia, so they could make their way to Martinique (Ernaut 1718).

Queen Anne's Revenge

About the same time *La Concorde* was completing its first slave voyage, Edward Teach began gaining notoriety as a pirate. It is uncertain when, exactly, Edward Teach began his career at sea, but it is hypothesized that he served aboard privateers during Queen Anne's War and afterwards turned to piracy. His career as a pirate probably began in 1716 when he made the acquaintance of Captain Benjamin Hornigold in the Bahamas. Hornigold had a reputation as a successful pirate and became something of a mentor to Teach. Teach joined Hornigold's crew and quickly made a name for himself due to his "uncommon Boldness and personal Courage" (Johnson 1724:86). Shortly thereafter, Hornigold raised Teach to the position of captain and gave him command of a sloop they had captured. The two continued their marauding as a team until the following year.

In late 1717, Hornigold and Teach came upon a French vessel off the island of St. Vincent (Lee 1974:14). They reportedly overtook the vessel so quickly that its captain was unable to maneuver into a defensive position. The pirates each fired one broadside before the captain surrendered. This ship, *La Concorde*, turned out to be an important prize not only for its cargo, but because it would go on to become Teach's flagship. The pirates' broadside barely damaged the hull structure. Teach "admired" the ship for its impressive size and speed and asked Hornigold if he could assume command of it as an upgrade from his sloop (Lee 1974:14). Hornigold agreed since he had been planning on retiring from piracy and had no need of such a vessel. The two pirates parted ways, Hornigold to accept the King's pardon, and Teach to embark on his own brief but notorious career (Lee 1974).

After acquiring *La Concorde*, Teach completed crafting his pirate "image" (Lee 1974:18). Lee suggests Teach was an educated man who knew that a psychological attack could serve just as well as physical attack in many cases. To strike fear in the hearts of victims, he grew thick black facial hair, hence his nickname, dressed in gaudy clothing, wore a bandolier of assorted weapons, and often placed slow-burning match cord under his hat brim to complete his fearsome appearance (Johnson 1724:99-100; Lee 1974:20-21). He wasted no time altering *La Concorde* to fit this image as well, arming it with as many as 40 guns (according to some sources) and 300 men, and changing its name to *Queen Anne's Revenge* (Hamilton 1718; South Carolina Court of Vice Admiralty 1719; Johnson 1724:63-64). Having a flagship that matched his own formidable visage helped solidify Teach's image as "Blackbeard." Shortly after fitting out his new vessel, Teach's reputation in battle was strengthened by a victory in an encounter with the merchantman *Great Allen*, which was taken "with little or no resistance" (Johnson 1724:64).

While at sea in March 1718, Teach and his crew crossed paths with another pirate ship, the ten gun sloop *Revenge*, captained by Major Stede Bonnet. Before turning to crime, Bonnet was a well-to-do planter from Barbados with little knowledge of sailing or life at sea; he seemingly became a pirate on a whim (Johnson 1724:60). For reasons unknown, Teach decided to ally himself with Bonnet for a time, perhaps because he felt the more inexperienced man would be easy to manipulate. Teach convinced Bonnet to give up control of *Revenge* by telling him "that as he had not been used to the Fatigues and Care of such as Post, it would be better for him to decline it, and live easy, at his Pleasure, in such a ship as [Teach's], where he would not be obliged to perform the necessary Duties of a Sea Voyage" (Johnson 1999:72). With the approval of Bonnet's crew who were supposedly close to mutinying, Teach placed one of his own officers in command of *Revenge*.

Shortly after the alliance with Bonnet, *Queen Anne's Revenge* and *Revenge* came upon the sloop *Adventure* on its way to Honduras Bay. Adventure was taken without a fight and its captain and crew all agreed to serve in Blackbeard's growing fleet, which must have seemed near invincible by this point (Johnson 1724). The pirate vessels continued on to Honduras Bay, where they captured and looted the *Protestant Caesar* and four accompanying sloops. They then headed to Grand Cayman, taking a turtle boat on the way, followed by stops at Havana and the Bahamas, where two more sloops and a brigantine were captured (Johnson 1724:65). In May 1718, Bermuda's Governor Bennett wrote the Council of Trade and Plantations that Blackbeard had been spotted nearby "in a ship of 36 guns and 300 men, also in company with them a sloop of 12 guns and 115 men, and two other ships, in all of which, it is computed there are 700 men or thereabout" (Hamilton 1718). This is most likely an exaggerated number; historians believe the fleet consisted of about 400 men total, but it serves to illustrate the great power Blackbeard had amassed in such a short period of time and the fear he instilled in his contemporaries (Lee 1974:38; Wilde-Ramsing 2009:119).

Perhaps the most famous event associated with Blackbeard's fleet is the blockade of Charleston harbor. At the end of May 1718, Teach made his way to Charleston, South Carolina, where he kept his four vessels lingering off the harbor mouth (South Carolina Court of Vice Admiralty 1719). Every ship going into or coming from the city was captured. After approximately one week, the fleet had stopped eight or nine vessels, including the Charleston pilot boat and the *Crowley*, which was *en route* to London with several of Charleston's most prominent citizens (Lee 1974:39). Traffic in the harbor ground to a halt as the city became aware of what was happening.

Meanwhile, cargoes from the captured ships were appropriated, and the crewmembers and passengers were questioned about other vessels in the harbor (Johnson 1728:310). The prisoners were locked below decks while the pirates held a meeting on what to do with them. It was eventually decided that the lives of the more prominent citizens could be used to bargain for something the pirates badly needed, medicine. One prisoner, escorted by two of Teach's men, was forced to carry ashore a list of required medicines and demand them from the town council in exchange for the citizens' lives (Johnson 1728:312-313; Lee 1974). If the demands were not met, Blackbeard threatened to kill the remaining prisoners and lay siege to the town. Since Charleston was already weak from an ongoing conflict with Native Americans and had no way to fortify against an attack from the sea, town leaders had little choice but to acquiesce to the pirates' demands and provide the medical supplies. Upon receipt of the items, Blackbeard ordered all prisoners and captured ships, minus their cargoes, released. The fleet left Charleston harbor and made its way north (Johnson 1724:67; Lee 1974:48).

The events that followed the blockade of Charleston harbor have been a source of debate amongst historians for years. On the heels of his most lucrative endeavor, Blackbeard lost three quarters of his fleet in the shallow waters off Beaufort Inlet, where *Queen Anne's Revenge* and *Adventure* ran aground and Bonnet's *Revenge* was shortly left behind. According to contemporary accounts assembled by Captain Charles Johnson, the vessels did not run aground by accident but as part of a scheme by Blackbeard to keep from dividing the spoils among so many men. Testimonies from the trials of Stede Bonnet's crew confirm this sentiment (South Carolina Court of Vice Admiralty 1719:46). According to Johnson (1724:67):

> Teach began now to think of breaking up the Company, and securing the Money and the best of the Effects for himself, and some others of his Companions he had most Friendship for, and to cheat the rest: Accordingly, on Pretence of running into Topsail Inlet to clean, he grounded his Ship, and then, as if it had been done undesignedly, and by Accident; he ordered Hand's Sloop to come to his Assistance, and get him off again, which he endeavoring to do, ran the Sloop on Shore near the other, and so were both lost.

It is believed that Blackbeard salvaged the most valuable cargo immediately after grounding, but there is no historical documentation to suggest that later salvage attempts were made by either the pirates or the people of Beaufort (Wilde-Ramsing 2009:132-135).

CHAPTER 5: HISTORY OF THE SITE

Introduction and Background

North Carolina shipwreck site 31CR314 was located on November 21, 1996 by divers with the private research firm Intersal, Inc. Intersal began surveying the waters around Beaufort Inlet in 1987 under a North Carolina Department of Cultural Resources (NCDCR) permit to search for the 18th century Spanish vessel *El Salvador*. An additional permit was obtained in 1989 that expanded the company's search rights to include Blackbeard's lost flagship *Queen Anne's Revenge* (Wilde-Ramsing 2006, 2009).

For nearly a decade, Intersal Inc. used systematic magnetometer surveys to find potential targets, then deployed divers to determine whether or not targets represented shipwreck remains. By 1996 they had located five wreck sites using this methodology. One site was thought to hold particular promise as divers found a cluster of nine cannon, two anchors, and a ballast pile. Several diagnostic artifacts were recovered including a bronze bell, a blunderbuss barrel, two cannon balls, a sounding weight, and a lead cannon apron. Analysis of these artifacts dated the wreck to the early 18th century (Wilde-Ramsing 2006, 2009). This information, along with the number of cannon observed on site, and historical documentation of more than 100 shipwrecks in the Beaufort Inlet region, helped narrow the wreck's identification down to one possibility: *Queen Anne's Revenge*.

After granting Intersal's permits in the 1980s, the North Carolina Department of Cultural Resources remained involved with the firm's search for *El Salvador* and *Queen Anne's Revenge*. Representatives from the NC Underwater Archaeology Branch accompanied Intersal on some exploratory expeditions. After tentative identification of site 31CR314, Intersal relinquished salvage rights to the wreck in exchange for media rights, and the State of North Carolina assumed stewardship of the site. It was felt that this agreement would maximize the archaeological and historical potential of the site and best serve the people of North Carolina (Wilde-Ramsing 2006:160).

1997-1999 Site Assessment

In the first two years after the QAR's discovery, state archaeologists worked to produce a comprehensive assessment of the site's significance. Methods used during this assessment period included non-disturbance remote sensing, test trenching, and mapping extant structural remains. Artifact recovery was limited to objects "likely to reveal age, origin, or ownership" except in the case of emergency excavations due to storm damage (Wilde-Ramsing 2009:69).

During the 1997 field season, the main ballast pile and surrounding extant features were mapped and Test Unit 1 was fully excavated to analyze site stratigraphy. Three sediment horizons were observed. The top layer consisted of mobile sand, the second layer was sand and coarse shell and contained the most artifacts, while the basal layer, on which the lowest points of all large artifacts rested, consisted of hard packed sand and silt (Wilde-Ramsing 2009:85). In addition to providing stratigraphic data, excavation of Test Unit 1 yielded an assortment of different artifact types and materials. Cannon C2 was recovered along with "ceramics, glass, wood, bone remains, two pewter dishes, numerous lead shot, and a large quantity of ballast stones and concretions" (Wilde-Ramsing 2009:86).

In 1998, a permanent baseline was established, as well as an off-site control point. Hull structure, newly uncovered by Hurricane Bonnie, was mapped during this season and three test trenches were dug across the site, perpendicular to the baseline. Unlike Test Unit 1, the 1998 trenches were not fully excavated; they were opened for exploratory purposes such as determining extent of the debris field and mapping portions of buried structure (Wilde-Ramsing

2009:82). After diagnostic artifacts were recovered, the trenches were filled in at the close of the season. In 1999 gradiometer surveys were used to locate and map buried ferrous materials without excavation (Wilde-Ramsing 2009:83).

Based on data collected during this assessment period, the UAB determined the site to be both highly significant and very threatened. They proposed a management plan that called for "site mitigation through total site data recovery at such time that permanent staffing and an adequate conservation laboratory could be put into place" (Wilde-Ramsing 2009:80). In the mean time, they recommended investigations continue without full recovery. The UAB's assessment was affirmed in 2004 when the *Queen Anne's Revenge* site was added to the National Register of Historic Places based on its association with an important event (piracy), an important person (Blackbeard), and an artifact assemblage that could reveal new information about early eighteenth-century life (Wilde-Ramsing 2009:69).

1999-2000 Emergency Recovery

The main goal of the 1999 and 2000 field seasons was the emergency recovery of hull structural elements uncovered by the previous year's hurricanes. A scour had formed around and under one side of the main mound, leaving ship timbers dangerously exposed (Wilde-Ramsing 2009:86). To prevent further damage, archaeologists recovered exposed timbers by cutting them at the point where they emerged from the main ballast pile. Emergency recovery efforts continued into the fall 2000 field season with a focus on collecting small finds associated with the zone where the frames were removed (Wilde-Ramsing 2009:86). It was during this season that a grid system, composed of five foot by five foot units, was first employed.

2001-2004 Site Monitoring

Between 2001 and 2004, the UAB continued monitoring the site during field seasons. The project still lacked a dedicated conservation facility, so recovery operations were seldom implemented (Wilde-Ramsing 2009:85). In 2001, divers conducted another gradiometer survey. In both 2003 and 2004, regularly buried portions of the site were temporarily exposed by storms, giving divers a chance to map them in detail. Also another test trench was dug in 2004. The trench uncovered a cannon previously located by gradiometer survey, thus confirming the gradiometer's accuracy. The trench also uncovered rigging remains, which by association, suggested the general location of the vessel's foremast. By the end of the 2004 season, approximately 15% of the site had been exposed with the test trenches (Wilde-Ramsing 2009:82).

2005-2006 Stratified Sampling

By the end of 2004, the QAR conservation lab was growing closer to completion, and site managers began to consider increasing artifact recovery operations during upcoming field seasons. Since previous recovery efforts were conducted on an emergency basis, they represented an uneven distribution across the site. To remedy this problem, a stratified sampling plan was devised that would fill in gaps around existing test units and trenches. This plan would not only supplement site assessment data, it would provide a "control collection" of artifacts in the event the site was destroyed before it could be fully excavated (Wilde-Ramsing 2009:87). The site was divided into seven sections across the baseline. Five interior sections were meant to roughly correspond to areas of the ship (stern, aft, midship, forward, bow) while the outer sections (offshore and nearshore) would serve to determine the north and south extent of the debris field. Using the grid system from previous years, 23 additional five foot by five foot units were excavated between spring 2005 and spring 2006. The stratified sampling operation proved a success. A control collection was recovered as intended, and new data surfaced regarding spatial analysis of artifact groups and associated activity areas on the ship (Wilde-Ramsing 2009:89). The stratified sampling also acted as a guide for the full recovery operation that would begin in fall 2006.

2006-Present Full Recovery

With a fully functioning and staffed conservation facility ready in fall 2006, QAR project managers were finally in a position to begin full recovery. Archaeologists started at the offshore end of the site and worked their way north using the five foot by five foot grid system. Each unit was uncovered using a three inch induction dredge connected to a sluice box at the surface where the output was hand-panned for small artifacts. This system allowed for efficient sediment removal while ensuring recovery of even miniscule finds including gold grains. By the end of the fall 2007 field season, over 150 units had been excavated, nearly half the site's surface area (Wilde-Ramsing 2009:90).

CHAPTER 6: A BRIEF HISTORY OF ARTILLERY

Introduction

Though the present study is geared specifically toward cannon aprons and not the cannon themselves, understanding the general history of artillery is a key to understanding the role of aprons and their place within that history. Advances and deficiencies in the art of gunnery directly influenced development of gunners' accessories and dictated their use. The history of cannon aprons, therefore, begins with a general history of artillery.

Some histories of artillery start off describing medieval "machines of war," early siege weapons such as catapults and trebuchets (Manucy 1949; Hogg 1970). Such histories are derived from a liberal understanding of artillery as any mechanism that throws projectiles too heavy for a person to throw by hand (Manucy 1949). A more conservative definition of artillery is "any non-personal offensive weapon in which gas pressure derived from the combustion of a propellant charge ejects a missile" (Hogg 1970:20). This study will use the latter definition since aprons were developed for use with weapons that depended on gunpowder; they would not have been used on machines of war.

Gunpowder

The origins of gunpowder are somewhat mysterious, but the substance is believed to have made its first appearances in China around the 8th century (Norris 2003:10). References supporting this theory include a Chinese account from 908 that describes soldiers using gunpowder blasts to disorient their enemies, and a Chinese military treatise from 1044 that lists an early gunpowder recipe (Contamine 1984:139; Norris 2003:10). Recipes for gunpowder were not standardized until several centuries after its invention, but its earliest forms always contained a combination of three key ingredients, potassium nitrate (commonly called saltpeter), charcoal, and sulphur (Partington 1999; Norris 2003:12-14,47). Ignited, the mixture generates nitrogen and carbon dioxide gases that expand to more than 300 times the original powder's volume (Manucy 1949:23). It did not take long to discover that by igniting gunpowder behind a projectile in a semi-sealed tube, the expanding gases would launch the projectile from the open end with tremendous force. The earliest known use of gunpowder to launch a projectile is attributed to Chinese General Ch'en Gui who invented a "long-barreled bamboo apparatus" known as *huo ch'iang* in 1132 (Norris 2003:10). The Mongols acquired knowledge of gunpowder, most likely during the conquest of China, and are reported to have incorporated it into their warfare by the 13th century (Contamine 1984:139). The circumstances regarding gunpowder's introduction to Europe are also a mystery, but historians believe it may have been brought either by Arabic traders or during the Mongol invasion in 1241 (Van Creveld 1989:83; Norris 2003:11-12). Regardless of how it was introduced, the first historical references of gunpowder in Europe begin in the mid 13th century (Norris 2003:11-14).

Prototypes

The earliest forms of gunpowder artillery are proto guns of experimental design and/or material that bear only a passing resemblance to the cannon of later years. The Arabic *madfaa* or *midfa*, a "small mortar-like instrument of wood" is one example (Manucy 1949:3; Partington 1999:205-207). Another proto gun, "shaped like an Indian club or a Chianti bottle…[and] made of leather, iron, or bronze" was used in Europe in the early 14th century (Hogg 1970:33). This weapon, which was called a *gonne* in England, a *vaso* or *schioppo* in Italy, and a *pot-de-fer* in France, is illustrated (Figure 8) and described in documents as early as 1326, but was obsolete by 1350 (Hogg 1970; Partington 1999:100). By this time, gun makers had moved on to more efficient designs.

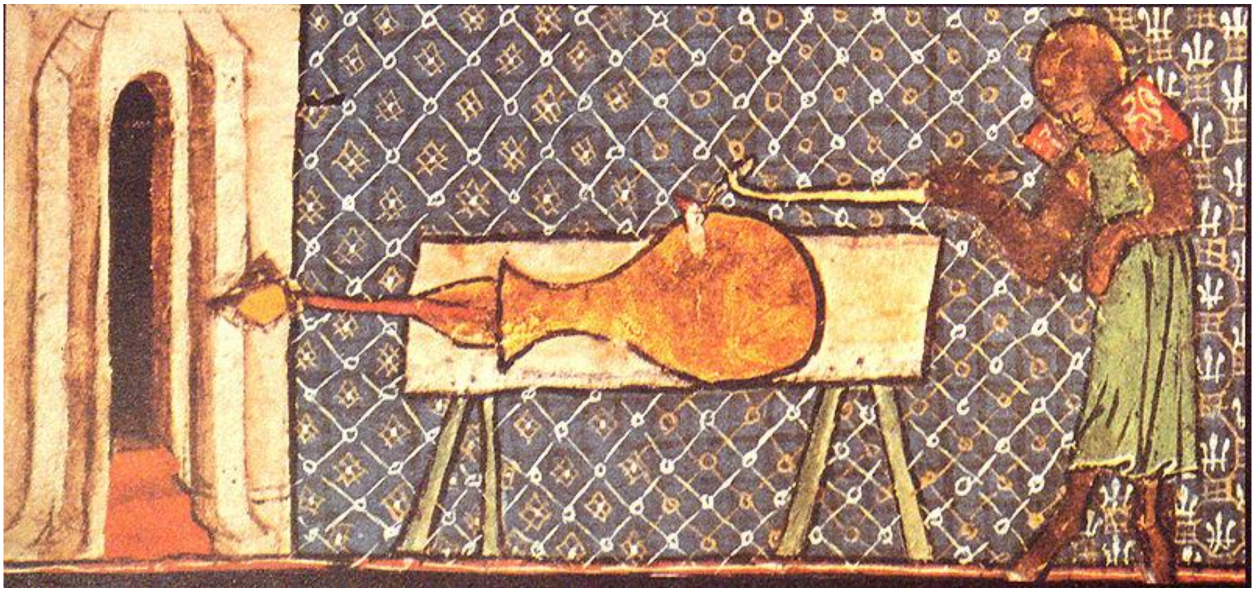


FIGURE 8. Proto gun illustrated by Walter de Milemete in De Nobilitatibus Sapientii Et Prudentiis Regum Manuscript, 1326 (Norris 2003:22).

After the experimental period of the proto guns, artillery history can be divided into three chronological phases (Hogg 1970:34). The first phase, 1350-1520, is characterized by wrought iron and cast bronze guns, the second phase, 1520-1854 by cast iron and cast bronze guns, and the third phase, 1854-present, is the modern era of artillery (Hogg 1970:34). This may seem like a gross oversimplification of a 600 year period of history, but artillery underwent relatively few changes during this period. Though the emergence of artillery in the 13th century was an important historical event, the associated technology was slow to develop (Hogg 1970:18).

Phase I: 1350-1520

14th Century

Wrought iron bombards were the successors to the experimental *vasos* of the early 14th century (Manucy 1949; Hogg 1970; Van Creveld 1989:86; Dastrup 1994:4). These weapons abandoned the earlier bulbous form in favor of a more cylindrical shape. Bombards were made in two styles, mortars with short fat barrels that produced high curved trajectories, or siege guns with long narrow barrels that produced low flat trajectories (Manucy 1949). They were made using a “hoop and stave” method in which iron bars (staves) were secured lengthwise around a mandrel, encircled with iron reinforcing rings (hoops) and then heated (Hogg 1970:35; Morin 2011:2). As the rings cooled, they shrank and pressed the bars tightly together, and then the mandrel was removed. The result was a tube open on both ends. The tube was then strapped to a wooden bed, or carriage, with enough room at the breech end to fit the gun’s chamber (a separately forged piece resembling a jug with a tapered neck). To load the weapon, the chamber was filled with propellant and locked into place against the barrel by hammering in a wedge (Morin 2011:2). This effectively sealed one end of the tube so the weapon could be fired (Hogg 1970:35).

Though they were an improvement over the proto guns, bombards and early breechloaders were still inefficient and dangerous weapons. The danger was largely due to not preventing gas from escaping the rear of the gun when firing (obturation) (Hogg 1970:36; Norris 2003:59). Eventually gun makers began welding the seams shut on wrought iron breechloaders, but this technique was only minimally successful. Achieving obturation was not as much of an issue with the bronze guns of the time, which were cast in the same process used to make bells (Hogg 1970:36; Kelly 2004:65). A clay mold was formed with a hollow space that corresponded to the shape and dimensions of the desired gun. A reinforced clay cylinder was then placed in the center of the mold to create the gun’s bore. Molten bronze was poured in the mold and allowed to cool, then the gun was removed from the mold and the casting sprue cut off. Since bronze guns were cast with one end of the gun tube already sealed, muzzle loading became necessary and obturation improved (Hogg 1979:36; Kelly 2004:66).

15th Century

Despite the advent of cast bronze muzzle loading guns, bombard style artillery continued to be used well into the 16th century (Dastrup 1994:5). There was a trend toward giganticism in the early wrought iron bombards that carried over to the cast bronze bombards as well. The Turkish bombard *Basilica*, for example, weighed 35 tons and could launch a 1600 pound projectile nearly 2000 yards (Dastrup 1994:5). Later in the 15th century bombards began to be constructed at a reduced size for use in field and naval artilleries (Morin 2011:2-4).

One of the most significant developments during the first phase of artillery history has to do with the manufacture of propellant. Around 1450, it was discovered that black powder is far more efficient when it is corned, or formed into large grains (Partington 1999:154; Norris 2003:48,55-56; Kelly 2004:60-63). This was accomplished by mixing regular black powder into a paste, pressing and drying it into cakes, milling the cakes into smaller pieces, and finally sifting and sorting according to grain size (Norris 2003:56). In previous years, gun powder was, as its name suggests, a slow burning fine powder or dust that created relatively low pressures inside the gun tube. It was hard to keep dry and quick to foul a gun's bore. The mid-15th century corned powder helped remedy some of these problems. Corned powder had several advantages over its predecessor:

1. It was less susceptible to damp, especially when glazed.
2. It deposited less residue after firing.
3. It did not stratify during transport.
4. It required less careful ramming.
5. Owing to the size of its grains and consequent greater surface and air spacing, it was consumed so rapidly that there was little or no escape of gas through the vent. As a result, it had, weight for weight, 33 1/3% more powder.
6. It produced less dust (Hogg 1970:129).

Corned powder created far greater pressures in a gun tube than earlier black powder, pressures too great to be used with 15th century wrought iron guns. Even though the techniques for its manufacture began in 1450, corned powder would not be used regularly with artillery until a century later when guns were strong enough to withstand the increased force (Hogg 1970:128).

Phase II: 1520-1854

16th Century

The second phase in artillery history was a time of major development. By the 16th century, improvements in casting techniques made it possible to replace the old wrought iron guns with lighter stronger cast iron ones (Manucy 1949). As guns became lighter, they became more portable and could be more easily used on ships and on the battlefield. The first use of mobile field artillery is credited to John Zizka, who placed guns on ox drawn carts during the early-15th century Hussite Wars (Manucy 1949:6). This technique was greatly improved in the 16th century using cast iron guns and horses (Manucy 1949:6). The science of ballistics also made great strides during this period. In 1537 Niccolo Tartaglia, often referred to as the "father of ballistics," wrote the first treatise on gunnery, *Nuova Scienzia* (Dastrup 1994:7; Norris 2003:134-135).

England's Henry VIII was a great advocate for artillery during the 16th century. When he first came to power, England had very few foundries and was forced to import most of its guns from other European countries. Henry knew that "the true defence of the realm lay in the maintenance of her sea power" (Hogg 1970:56). He also knew that maintaining power would require many guns, which could be obtained more quickly and cheaply if they were manufactured in England rather than abroad. To help promote an "in house" gun founding industry, Henry brought in foreign gun makers to set up foundries and teach their trade to English apprentices (Norris 2003). With the increase in local gun production, Henry had no problems ensuring his ships and ports were heavily armed. While he was not the first ruler to use naval artillery, Henry was certainly instrumental in establishing a precedent for its importance.

Switching from wrought iron to cast iron was the first big step towards lightening artillery, but 16th century guns and carriages were still incredibly cumbersome to maneuver (Manucy 1949:6; Van Creveld 1989:87). It took as many as 23 horses to move a cannon over even ground. Pikes and muskets remained the preferred weapons on the battlefield due to a lack of "mobility, organization, and tactics" with artillery (Manucy 1949:6-7). The preference began to shift in the 17th century with improvements introduced by Gustavus Adolphus of Sweden (Manucy 1949:7; Hogg 1970:25-26; Dastrup 1994:11).

17th Century

Gustavus Adolphus recognized the need for highly mobile field artillery and felt it could be accomplished using lighter guns (Fletcher 1963:121; Dastrup 1994:11). It was from this idea that the Swedish "leather cannon" developed. This gun was actually a small copper tube covered with layers of cord, plaster, and leather that was reportedly so light it could be served by as few as two men. Though capable of launching a three pound projectile, its lack of power made the leather gun more of a novelty than a weapon (Dastrup 1994:11). As an alternative, Gustavus created a bronze gun of the same dimensions as the leather one; it proved only marginally more effective. Eventually he commissioned his artillery chief to develop a cast iron 4-pounder and a 9-pounder demiculverin, both of which could be served by three men; these became the staples of his field artillery (Fletcher 1963:121; Dastrup 1994:11). The new pieces were praised for their mobility and ease of use, and were soon adopted by other armies. Gustavus Adolphus also improved the speed of firing artillery by introducing cartridges, projectiles and predetermined amounts of gunpowder combined in the same package. Cartridges eliminated the time consuming practice of ladling the charge in which the powder was carefully measured and positioned before each shot, decreased the time between firings, and increased accuracy. For these and other innovations, Gustavus Adolphus is said to have "laid the foundations for the appearance of true field artillery" (Dastrup 1994:11).

Demonstrated success of the Swedish improvements led to a greater importance placed on the role of artillery. Other nations began standardizing calibers around this time and civilian artisan gunners were eventually replaced by professional soldier gunners (Manucy 1949:8). Another notable 17th century development was the invention of the howitzer. Howitzers were created by the Dutch to be a more mobile version of the mortar. They fired projectiles at a medium height and range, somewhere between the mortar's high curved trajectories and the culverin's low flat trajectories. Howitzers were primarily used for siege warfare and field artillery (Hogg 1970:94).

18th Century

Most changes to artillery in the 18th century came about due to John Muller, the master gunner of Woolwich. Muller's primary goal was to increase caliber size without increasing gun weight (Muller 1780). He felt strongly that technological advances for artillery had been stymied by gunners' refusal to break with tradition. Some traditional, and inefficient, practices that Muller overturned were heavy ornamentation on guns that added unnecessary weight, and trunnion placement near the base of the gun tube which put great strain on carriages (Muller 1780:41-43,51). Muller also called for a change in the traditional amounts of powder used for a charge. The tendency at the time was to use the maximum amount of powder to produce as tremendous a blast as possible, but the more powder used, the thicker the walls of the gun had to be to withstand the added pressure. Muller promoted using smaller powder charges so that guns could be cast with thinner walls, thereby greatly decreasing their weight and increasing their mobility (Muller 1780:37-39).

Another 18th century artillery development was the flintlock mechanism that improved the means of firing a gun (Hogg 1970:149; Tucker 1989:32). In the 14th and 15th centuries, charges were ignited with a red hot spike, held with a pair of tongs. By the mid-15th century this dangerous practice was abandoned in favor of filling the vent with loose powder and igniting the priming powder with slow match, a nitrate soaked cord. In the 16th century guns were fired using linstocks, slow matches held at the end of wooden staffs that allowed the gunner to ignite the charge from a distance and escape potential injury from recoil (Manucy 1949:26; Tucker 1989:28-29). In 1778 Sir Charles Douglas encouraged the use of flintlocks on all guns, but the Royal Navy did not officially adopt the practice until 1790 (Tucker 1989:32).

Carronades were introduced around this time as well. As a hybrid gun/howitzer, this short fat weapon was known for its destructive power and nicknamed “the smasher” (Lavery 1987:107). Carronades were significantly lighter than other guns of the period but were capable of launching much heavier projectiles. This was possible for several reasons. First, since they were designed as short-range weapons, the length of the muzzle could be much shorter than typical sea service guns. They also required less gunpowder because the shot was not intended to go far, and could therefore be cast with thinner walls and less metal. Finally, carronades had reduced windage, which meant that less air escaped from the space between the projectile and the gun bore (Lavery 1987:105). These qualities made carronades popular with the Royal Navy for several decades but they began to fall out favor after the War of 1812. The U. S. Navy, however, continued to use carronades until the mid-19th century (Tucker 1989:127).

Phase III: 1854-Present

19th Century

The third phase of artillery history was prompted by the desire to create rifled weapons. Rifling is a series of lands and grooves that spiral around the inside of gun's bore with the purpose of spinning the projectile as it is fired. Rotational velocity increases steadiness in flight, extends range, and gives better accuracy (Hogg 1970:80). Though the concept of rifling was known as early as the late 15th century, the practice did not gain widespread popularity with great ordnance until the mid-19th century (Van Creveld 1989:85; Norris 2003:60). Around this time, both British and American gun makers were simultaneously experimenting with rifled gun designs. In a new take on an old concept, the first rifled weapons of this time were wrought iron breech loaders, similar to guns of the 15th century. Ultimately though, this design was flawed; even after several centuries, gun makers still struggled to make breechloaders that could achieve obturation (Hogg 1970:85). As a compromise between the traditional design and the new design, many nations opted to convert smoothbore muzzleloaders to rifled muzzleloaders. Examples of artillery that developed from this hybrid design include British RML ordnance, American Columbiads, Parrott, and Rodman guns (Hogg 1970:85-86). By the end of the 19th century, technological advances such as the Welin breech-screw, obturation pads, and brass cartridge cases made it possible to create breech loading guns that were capable of complete obturation (Hogg 1970:87)

20th Century

Artillery technology grew by leaps and bounds in the 20th century. Steel replaced iron and bronze as the favored gun metal and new chemical propellants took the place of black gunpowder (Manucy 1949:20-21). There were many other advancements in this period as well, but the present study is primarily concerned with the era of the smooth bore muzzleloader and will not examine the history of artillery beyond the development of 19th century breech loading guns.

The Role of Aprons

Historical references show that an apron is a sheet of lead that was lashed over the vent of a loaded gun to keep the charge dry, the chamber debris free, and prevent accidental fire (Smith 1627, 1691:89; Binning 1677:109; Seller 1691:158; Povey 1702:43-46; Smith 1779:9; Tousard 1809:132,136; Simmons 1812:104; Adye 1813:2; James 1821:19; Blackmore 1976:218; Boudriot 1986:169; Caruana 1994:73). Beyond this basic function, little is known about aprons. Primary source documentation on aprons is scarce and the references that do exist are terse, so it is somewhat difficult to gain an understanding of how aprons fit into the history of artillery.

16th Century

When aprons first came into use is uncertain; the earliest known reference in England is a 1595 Tower of London inventory for the Rochester Storehouse that mentions "covers of lead for the touches of ordnance" (Offices of the Ordnance and Armoury 1595; Blackmore 1976:224; Alex Hildred 2011, pers. comm.). This roughly coincides with the date of the oldest archaeological example of cannon aprons (Figure 9) from the Alderney Site ca. 1590 (Alderney Maritime Trust nd). There appear to be no archaeological or historical examples of aprons prior to the late 16th century, but this is not altogether surprising since wrought iron breech loaders were still widely used up to this period; these would not require an apron since they had a removable chamber instead of a vent field. Though the technology for casting iron guns was known to exist in the early 1500s, cast iron muzzle loaders were not yet a prominent form of ordnance in the mid 16th century. The armament of King Henry VIII's *Mary Rose*, for example, consisted primarily of cast bronze muzzle loaders and wrought iron breech loaders (Hildred 2011:7). No lead aprons have been identified from the *Mary Rose*, an absence that makes sense since breech loading guns would not have needed them and the bronze muzzle loading guns appear to have had small hinged touchhole covers (Figure 10) (Hildred 2011:417; Alex Hildred 2011, pers. comm.). The advent of lead aprons, therefore, seems to have occurred sometime between the mid and late 16th century.

17th Century

FIGURE 9. Apron from the Alderney site, circa 1590 (Photo courtesy of the Alderney Maritime Trust).

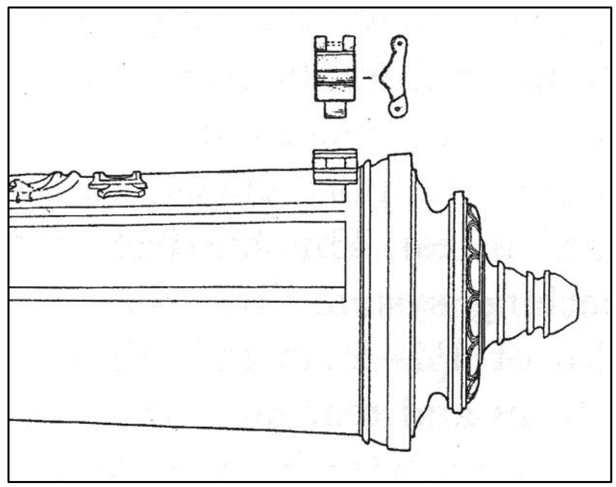


FIGURE 10. Detail of *Mary Rose* Cannon 81A3003 with hinged touchhole cover (Hildred 2010:51).

Gunners' treatises from this period offer little illumination on the subject of aprons. Tartaglia's (1588) 16th century treatise on ballistics does not mention vent covers or aprons but it repeatedly stresses the importance of keeping gunpowder dry (an apron's primary function). For the next hundred years, treatises tended to follow the precedent set by Tartaglia in that they focused primarily on ballistics rather than gun use and maintenance; aprons were not mentioned (Bourne 1643; Eldred 1646; Nye 1647; Roberts 1668; Moretti 1673). Toward the end of the 17th century, aprons finally began to make appearances in gunners' manuals. Interestingly this is the same time when the manuals started splitting sea gunnery and land gunnery into separate subjects; aprons occurred more frequently in the sea gunnery volumes (Binning 1677:109; Seller 1691:158; Smith 1691:89; Povey 1702:43-46; Simmons 1812:104). It could be that initially aprons were only used at sea, where it would be significantly more difficult to keep gunpowder dry; until manuals were published with instructions specific to sea gunners, the treatises had no reason to mention aprons. Even if this hypothesis is correct, later manuals prove that aprons had, at the latest, been incorporated into field artillery equipment by the 18th century (Povey 1702:56-59; Tousard 1809:132,136).

Though references appear more frequently in the late 17th century, the extent to which aprons were described in gunners' manuals was succinct at best. *The Sea-Man's Grammar and Dictionary* describes aprons by purpose, but not by name, in a selection that reads, "A Tomkin is a round piece of wood put into the Pieces mouth and covered with tallow, and a Fid or Fuse, a little Okum made like a Nail put in at the Touch hole, and covered with a thin Lead bound above it to keep the Powder dry in the Piece" (Smith 1627:68, 1691:89). Ironically the self described purpose of the chapter is to declare "the Names of all sorts of Ordnance…their Appurtenances…and proper Terms" but it never used the proper term for aprons (Smith 1691:85).

The term "apron" will often appear only in step by step instructions for how to serve a gun, such as in *A Light to the Art of Gunnery* which reads:

> The Guns being dimensioned and clean as aforesaid, the Gunner shall take half a Ladle of Powder for every Gun, and blow them off, Sponge them well; and finding them clean, Load then the Peece or Guns with their respective Cartradges and Powder; which being rammed home, with a strait Wad after it, then let the Ball roll home to the Wad, and set a Wad close home to the Ball, that the Ball roll not out with the tumbling of the Ship; then must he Tamken the Peece at the Mussle or Bore, with a Wooden Tampken, which he must Tallow with hard Tallow round about for preserving the Powder from Water; Likewise make a little Tapon of Oakum for the Touch hole, which must be tallowed also for Water, before the Leaden Apron be put over; then make your Peece fast as occasion best presents (Binning 1677:109).

This is the only mention of aprons in the 173 page document. One section of the manual lists necessary equipment for sea gunners, but aprons are omitted (by name at least). The list includes powder, shot, tompions, match, rammers, worms, ladles, sponges, beds, and quoins, which it would seem were prefabricated. The list also includes marline, mallets, and sheet lead, some of the materials used to make aprons, suggesting that perhaps they were not prefabricated but made as needed at sea. If this were the case, it would seem logical for the manual to include instructions for making aprons, but it does not. Apron manufacture may have been common knowledge, or maybe it was considered too simplistic a process to need explanation. *The Sea-Gunner*, published about 30 years after *A Light to the Art of Gunnery*, contains an identical list of gunners' stores and a similar description of how to keep a gun vent dry, and *does* mention aprons by name (Seller 1691:158).

Early to Mid-18th Century

By the early 18th century, manuals like *The Sea-Gunners Companion* not only mention aprons by name, but their lists of stores include what appears to be prefabricated aprons as well as sheet lead, according to the number of ships' guns (Povey 1702:34). 100 aprons are required for a 1st rate ship, 90 for a 2nd rate ship, 80 for a 3rd rate ship, 60 for a 4th rate ship, 40 for a 5th rate ship, and 30 for a 6th rate ship. The volume also instructs the master gunner to "appropriate a fit Number of Men to each Gun, fixing their Names over each gun, making one as Foreman or Director in managing the Gun" (Povey 1702:40). This is particularly noteworthy in considering apron markings. Povey does not explain how the names are to be fixed over the guns, but it could be possible that they were inscribed on the aprons, which, if true, would constitute a secondary function for the objects. This theory supports Boudriot's (1986:169) claim that aprons on 18th century French naval vessels were "engraved with the number of the gun, and with the names of the gun-captain and guncrew."

The Sea-Gunner's Companion, like many manuals before it, includes a description of how to load a gun; the instructions, however, are far more specific than in previous volumes. The steps are to be called out by the master gunner and carried out by the crew. The first few steps for serving a gun include a call for silence and the removal of the apron. The gun is to be sponged, loaded, and primed, and then the apron is to be replaced until it is time to fire (Povey 1702:43). The apron is subsequently removed for firing and replaced after loading each new charge until the end of the drill or engagement when it is lashed back in place with marline. The specific nature of these instructions and the fact that aprons finally appear in lists of ships' stores indicate a move toward naval standardization in the 18th century.

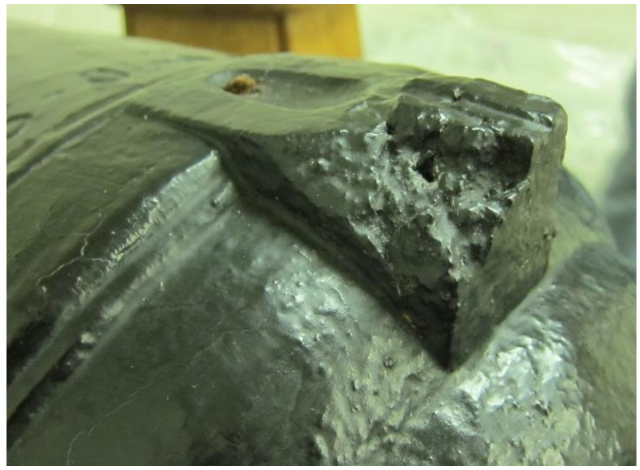
With regard to the hypothesis that aprons may have initially only been used at sea, it is noteworthy that *The Sea-Gunner's Companion* includes a section of instructions for land gunnery, in which both lead and leather gun covers are described. For a ten gun field artillery train Povey (1702:59) calls for ten aprons as well as rolls of sheet lead to make extras. The section of the manual on battery guns does not mention lead aprons, but does call for tanned hides and "tarr'd paulins" to cover the gun's breech in rain (Povey 1702:55). The use of tanned hides or leather aprons may not have been uncommon in sea gunnery either. According to *The Compleat Gunner*, "the Piece, having its due Charge of Powder and Bullet, he must cover the touch-hole with an Apron made of Lead, or for want of that, with dryed Sheep-skin" (Anonymous 1672:50). This reference indicates that aprons were made of both materials, but that lead was preferred. No explanation is given for why lead is the preferred material. Neither leather nor lead would cause a spark and both could be formed to the shape of the gun. Leather, however, might become cracked and brittle in a maritime environment faster than lead would corrode.

As evident from some previous references, gunners' treatises also describe an object called a "fid" that was used in conjunction with aprons for a time. A fid was a small oakum plug used to seal a touchhole when a gun was not in use; once the fid was in position, a lead apron would be secured over the entire vent field (Smith 1627:68, 1691:89; Blackmore 1976:230). Small remnants of fids were observed in three guns recovered from the QAR site (Henry 2009:13). Based on their absence in later manuals, fids seem to have fallen out of favor by the mid 18th century, perhaps because they were prone to fouling the touchhole and increasing the time in which a gun could be served, but aprons remained a somewhat understated necessity for the next several centuries.

Late 18th to Mid 19th Centuries

As artillery became more standardized in the 18th century, so too did cannon aprons. By 1779, English naval treatises began publishing predetermined sizes of aprons for the appropriate guns. Aprons 15 inches long by 13 inches wide (38.10 by 33.02 cm) were used for 42, 32, and 24 pounders, aprons 12 inches long by 10 inches wide (30.48 by 25.40 cm) were used for 18, 12, and 9 pounders, and aprons 10 inches long by 8 inches wide (25.40 by 20.32 cm) were used for 6, 5¼, 3, and 1½ pounders (Smith 1779:9; Blackmore 1976:218). Even the lengths of marline used to secure the aprons were standardized (Smith 1779:9). In the 18th century apron form also began changing to accommodate the advances in artillery. The advent of the flintlock mechanism and the raised vent patch, for example, both required a change in apron form. These changes are not apparent in historical documentation but in the archaeological record. Lead aprons recovered from *Pomone* (1811) have large "humps" on one side to accommodate gunlocks (Bingeman 2010:126). The aprons recovered from *De Braak* (1798), have been crimped to fit snugly over the raised vent patches on carronades (Figure 11) (Charles Fithian 2011, pers. comm.).

A



B

FIGURE 11. *De Braak* artifacts: *(a)* carronade apron; *(b)* detail of carronade vent patch (Photos by author, 2011).

Conclusion

Though they have been described briefly in inventories and treatises for almost 300 years, there are many questions about aprons left unanswered by historical documentation. Method of manufacture or procurement is not mentioned, but the literature alludes to a shift from manufactured-as-needed aprons of indeterminate size and form, to more standardized prefabricated designs. Neither do the manuals specify the beginning and end of the time period during which aprons were used, but inferences can be made based on archaeological examples. The estimated date of the Alderney apron, and the fact that aprons likely became obsolete as breech loading guns were reintroduced provides an approximate date range from the mid-16th century to the mid-19th century for apron use.

There are other unanswered questions that pertain to aprons' overall form. Some morphological changes are easily explained, such as the *Pomone* humped aprons for flintlock guns (Figure 12) (Bingeman 2010:126-127). Still others remain ambiguous, such as why some aprons like those from the QAR have fingers and others do not. Perhaps the biggest mystery revolves around markings on aprons, which are never explicitly referenced in any primary source material accessed by this study. Secondary sources make reference to apron markings that correspond to gun types and sizes, but this explanation does not seem to fit markings on the QAR aprons (Bingeman 2010:126). It is the goal of the archaeological documentation described in the following chapters to help answer some of these questions.

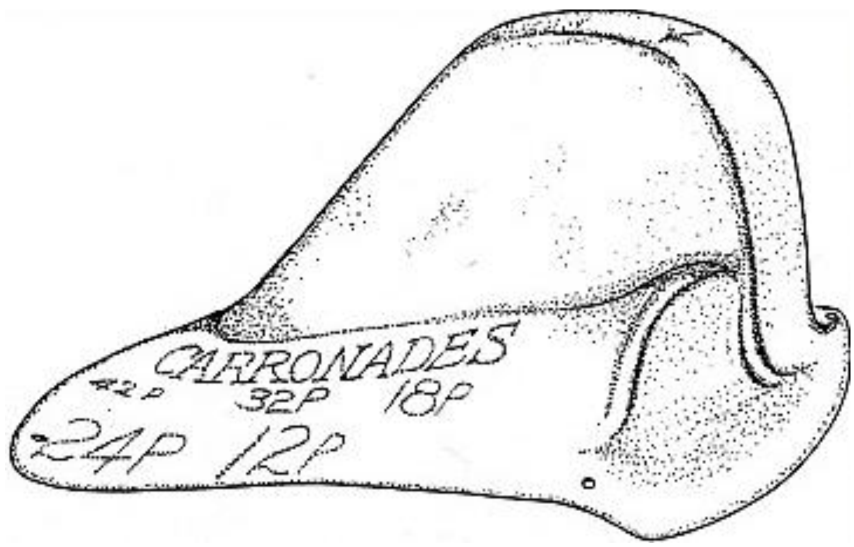


FIGURE 12. *Pomone* apron meant to fit over a flintlock mechanism, drawing by John R. Terry (Bingeman 2010:127).

CHAPTER 7: DOCUMENTATION RESULTS

Introduction

The following section represents a catalog of the documented QAR aprons and synopses of the results from the cultural analysis forms. It is important to note that only 12 of the 13 QAR aprons have been fully recorded. QAR 1321.001 will be discussed in the Interpretations section regarding effects of conservation processes, but the artifact has not yet been documented with the cultural data form because it is still treatment.

Catalog and Notes

Artifact Number: QAR 1104.001

Provenience: Unit 10/06 #77 E78 N34.5

Length: 280 mm

Width: 230 mm

Weight: 1858.1 g

Thickness: 3.0-3.5 mm

Number of Fingers: 7

XRF Data: No

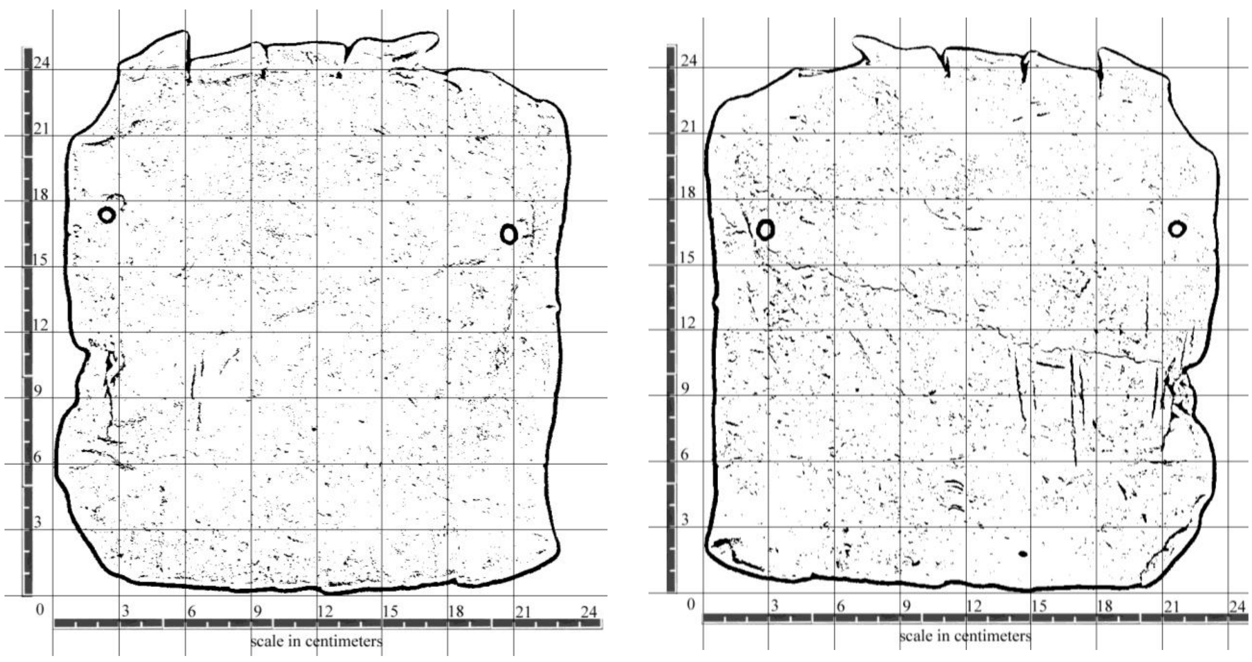


FIGURE 13. QAR 1104.001: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

Artifact 1104.001 (Figure 13) has seven fingers along Side 1 and no spaces suggesting missing or cut away fingers. The cross-sectional edges of all four sides are unifacial in some areas and rounded in others. The dimensions of the fingers are fairly uniform, all about 30 mm by 30 mm, and all fingers have unifacial cross-section edges. All fingers are curled in toward Face A to varying degrees. There are two circular fastener holes, each about 10 mm in diameter with bifacial cross-sectional edges. The edges have been somewhat flattened and at first appeared like an impression from a rivet.

The apron has a matte gray patina. Markings on Face A include cut marks all the way through the lead in cell (6,9), a convex circular depression 5 mm in diameter in cell (6,0), an abraded crease about 2-3 mm wide running from Side 4 (3,9) up and across to H2 (18,15), and a second abraded crease spanning from cell (18,9) to cell (21,18), an irregularly shaped depression in cell (15,12), a 15 mm linear depression in cell (6,9), and a small 1.5 mm gouge in cell (9,6). Also of note are three rectangular areas, one in each bottom corner and one in the top right corner, where the patina is significantly darker.

Markings on Face B include two circular depressions 3 mm in diameter, located in cells (9,0) and (12,0), one of which is also visible on Face A, a shallow gouge in cell (18,9), several 8 mm long crescent shaped depressions in cell (9,3), linear depressions in cells (12,9), (15,6), and (15,9), and the crease visible on Face A that spans from Side 4 to H2. There is also a large convex indentation that could correspond to the location of a gun's base ring.

Artifact Number: QAR 1498.000

Weight: 2948.2 g

Provenience: Unit 08/07 #95 E82.5 N37

Thickness: 4.0-4.5 mm

Length: 310 mm

Number of Fingers: 5

Width: 245 mm

XRF Data: No

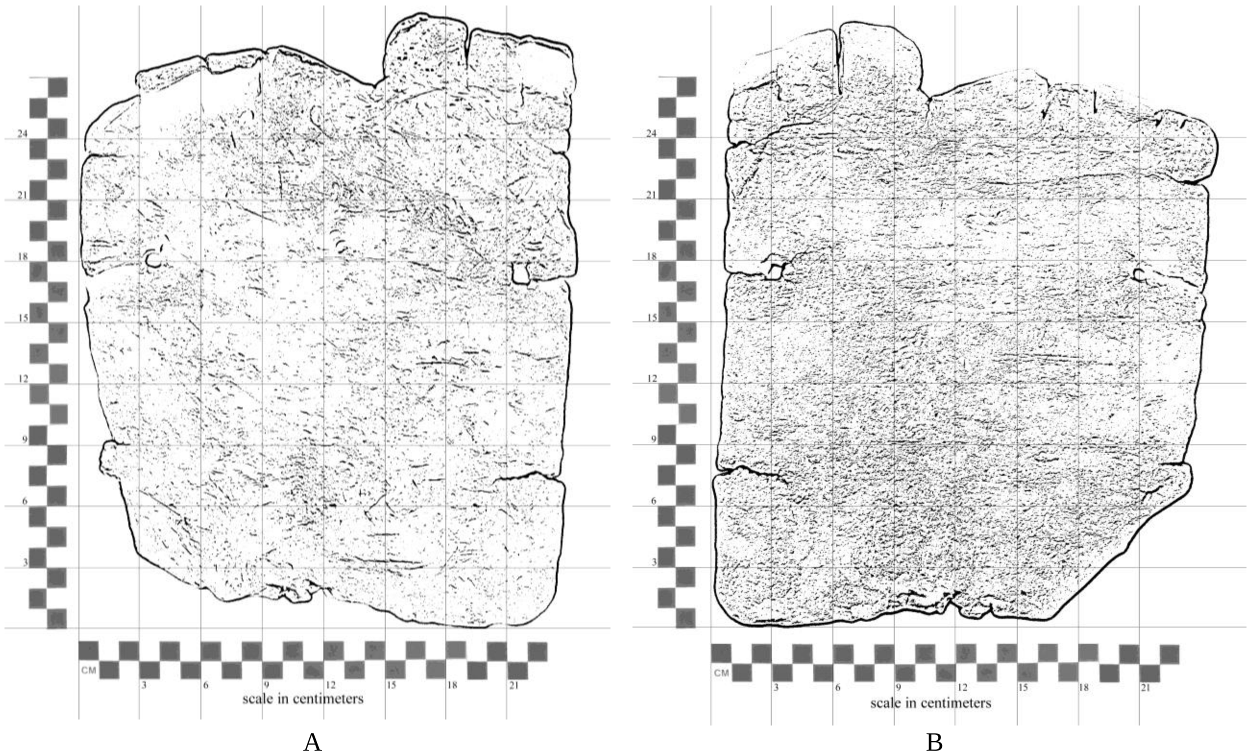


FIGURE 14. QAR 1498.000: *(a)* Face A; *(b)* Face B. (Figures by author, 2011.)

Artifact 1498.000 (Figure 14) has existing fingers along Side 1 and two spaces for missing fingers. This artifact is in a state of greater deterioration than 1104.001; the metal is cracked and torn around the sides of the object and the cross-sectional edges cannot be determined as unifacial, bifacial, or rounded. The existing fingers are all approximately 30 by 30 mm, as is the base of missing F1. The base of missing F4 is 62 mm wide and may therefore represent two missing fingers instead of one. Some of the cross-sectional edges of the fingers are intact enough to be determined as unifacial. There are two fastener holes, one of which is clearly circular. The shape of H2 is difficult to determine due to cracks in the surrounding metal.

Both holes are 10 mm in diameter with unifacial cross-sectional edges. Stress marks around the fastener holes indicate the use of marline to secure the apron to a gun.

The object has a matte gray patina with patchy areas of thin white and orange corrosion. Marks on Face A include light scoring on F1, F6, and F7; circular depressions in cells (6,24), (9,21), and (12,21); crescent depressions in cell (12,18); a linear gouge, 4 mm at the widest point, which spans cells (12,3) and (15,3); a crease in the lead (convex on Face A) between H1 and Side 4; another shallow crease arced downward between H1 and H2, several linear depressions about 7 mm in length around H1 and H2; and repeating crescent score marks in cell (6,6) and cell (18,21). There are cracks in the lead running laterally into Sides 2 and 4, and Side 3 appears as though it has been torn. The bottom two corners of the apron (where Side 4 and 3 meet and Side 2 and 3 meet) are rounded.

There are virtually no markings on Face B. The surface of the lead is pitted, abraded, and cracked and in generally poorer condition than the surface of Face A. There are linear striations running laterally across the entire surface, parallel with Sides 1 and 3. These striations are not believed to be cultural markings.

Artifact Number: QAR 1486.000

Provenience: Unit 08/07 #95 E83 N39.5

Length: 250 mm

Width: 230 mm

Weight: 1830.2 g

Thickness: 3.0-4.5 mm

Number of Fingers: 7

XRF Data: No

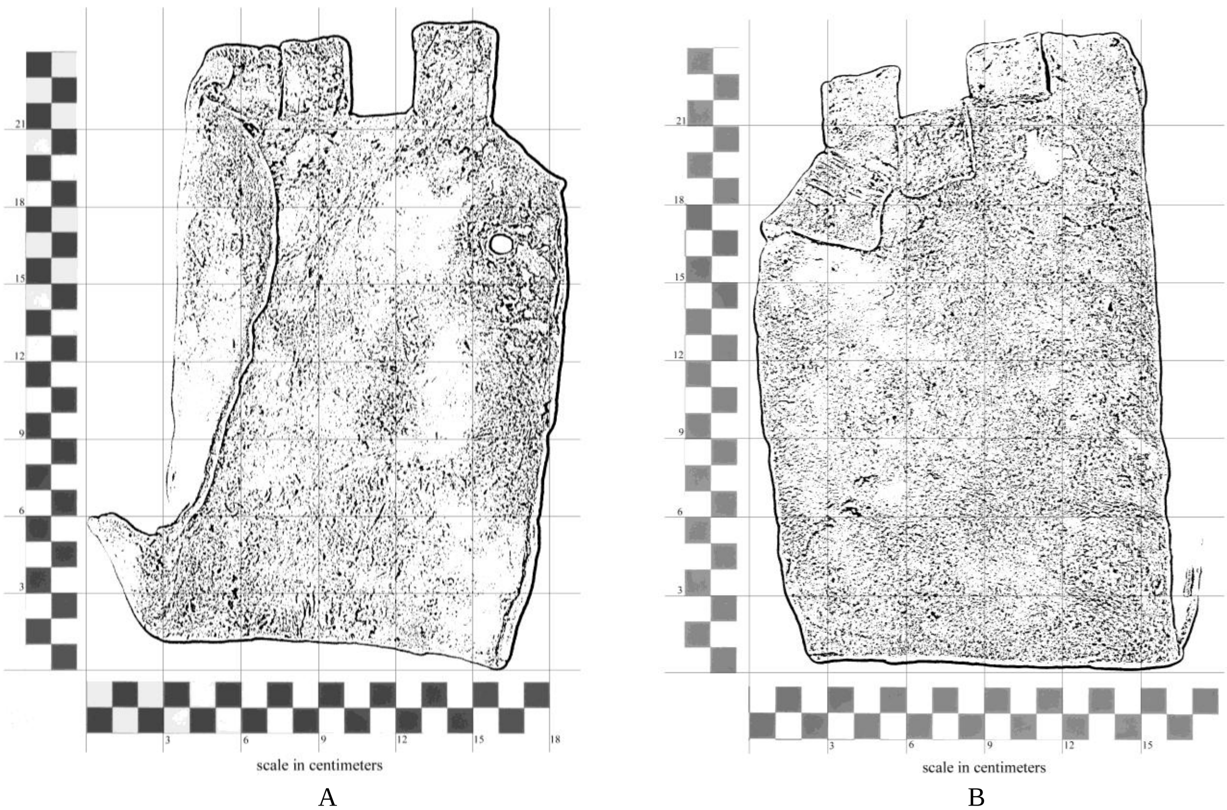


FIGURE 15. QAR 1486.000: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

Artifact 1486.000, like 1104.001, has seven fingers along Side 1 and no spaces for missing fingers (Figure 15). The edges of all four sides are pitted and worn (rounded/filed) but the cross-sections of Side 2 and Side 3 retain a unifacial shape in some areas. There is an angular sprue of excess lead along Side 2 and marks along Side 4 that could be the result of cutting the edge with a chisel. As with other aprons, the fingers on 1486.000 are all within a few millimeters of 30 by 30. The cross-sectional edges of the fingers, with the exception of side a (the top edge), are nearly all unifacial. The object has two circular fastener holes, each about eight mm in diameter with bifacial cross-sectional edges. There is comparatively little wear on this apron around the fastener holes, suggesting it was not used to the same extent as other aprons.

This apron has a light gray patina with a matte finish. The surface is mottled with lighter gray patches that may correspond to areas of pre-treatment concretion. Markings on Face A include small circular depressions in the lower right corner, (12,0) to (18,3), squiggly linear indentations (concave on Face A) spanning cells (9,6) to (15,9) and (6,15) to (12,18), and score marks running parallel to Side 2. There is also a small "x" incised in cell (12,15) and small linear indentations/cuts in cells (9,6) and (12,6). There are irregularly shaped depressions near cell (6,6) that resemble the impression of laid rope; the total length of this mark is 20 mm but it is comprised of three smaller marks each about 7 mm in length. There appears to be scoring inside the fold, near Side 4, but the marks are hard to measure or photograph due to their location.

Face B has very few markings. The linear indentations noted on Face A are visible as convex indentations on Face B and there are several areas of abrasion in cells (12,6) and (12,3). There is a crescent shaped gouge in cell (3,6) approximately 8 mm long and 3 mm wide. Scoring is visible on F7 which is technically on Face A, but due to the finger's bent orientation the markings appear on the image for Face B. Also on Face B there is a shallow cut in cell (0,0) running parallel to Side 3 and three shallow indentations slanting into Side 3 in cells (3,0), (12,0), and (15,0). These are similar to the marks in Sides 2 and 4 visible on Face A.

Artifact Number: QAR 0002.000

Provenience: E80-100 N70-85

Length: 240 mm

Width: 215 mm

Weight: 1360.0 g

Thickness: 3.5 mm

Number of Fingers: 6

XRF Data: Yes

A B

FIGURE 16. QAR 0002.000: *(a)* Face A; *(b)* Face B (Photos courtesy of NCDCR, 2011).

Artifact 0002.000 (Figure 16) was recorded differently than the other aprons. To test the usability of the cultural data form, a QAR Lab staff member was asked to record the object based only on the template's instructions. The results were mostly successful. Template Part I was completed in a similar manner to those of other aprons. Template Part II, however, caused some confusion and the QAR staff member opted to print photos of the apron on which to annotate surface markings rather than use the black and white grid image. The resulting data is comparable to that collected from the other aprons, but slightly less detailed.

Apron 0002.000 has six fingers along Side 1. There are no obvious spaces for missing fingers, but there is a 25 mm indentation between Side 4 and F1d, where the two edges meet together seamlessly on the other similar aprons. The edges of all four sides are rounded in cross-section, with the exception of a few unifacial segments along Side 4. All six fingers are approximately 30 by 30 mm. Fingers sides b and d are nearly all unifacial in cross-section, but like apron 1486.000, the a sides (top edges) of the fingers are all rounded. There are two fastener holes; H1 which is about seven mm in diameter, and H2, which is about nine mm in diameter. A tear in the lead between H2 and Side 2 has elongated fastener hole H2 and accounts for the difference in diameter.

Face A has a mottled gray patina and a few patches of bluish white corrosion, perhaps from residual concretion. There are virtually no markings on Face A except for a linear indentation across the bottom half of the object. Face B has a few more markings, including a 21 mm square of crosshatching below F3, some gouges, possible percussion marks, a linear depression beneath F6, and a linear depression spanning from H2 to H1. This last mark, along with distortion around the fastener holes indicates that marline was threaded over the center of Face B and under the edges of Face A. Overall the apron has a curvature that is convex on Face B.

Artifact Number: QAR 1269.000

Weight: 4111.7 g

Provenience: Unit 11/06 #76 E76.5 N38

Thickness: 3.5-5.0 mm

Length: 295 mm

Number of Fingers: 2

Width: 350 mm

XRF Data: No

A B

FIGURE 17. QAR 1269.000: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

Artifact 1269.000 (Figure 17) is the largest QAR apron, at about 300 mm wide by 350 mm long. It has two existing fingers along Side 1 and one space in the center from where a finger may have been broken or purposely removed. All four sides of the object have rounded cross-section edges, with the exception of a few unifacial areas on Sides 2 and 4. The edges of the fingers are all rounded in cross-section or too worn to determine. The fingers on 1269.000 are unique because they are trapezoidal rather than rectangular, their top edges (F1a and F3a) are about 35 mm shorter than the base edges (F1c and F3c) and the inside edges (F1b and F3d) are slanted to accommodate this formation. This apron has two circular fastener holes approximately 15 mm in diameter. H1 has a very clear unifacial cross-sectional edge, but the cross-sectional shape of H2 is difficult to determine because the metal is torn between H2 and Side 2.

Artifact 1269.000 has, by far, more markings than any other QAR apron, most of which appear on Face B. Face A has a medium gray matte patina with light gray speckles that look like remnants of concretion. There are some faint scuff/drag marks and linear abrasion above and the right of H1 in cells (3,18), (6,18), and (9,18), a 55 mm long cut through the lead spanning from cell (15,12) to (21,9), and two concave linear indentations from possible base ring or reinforcing ring impressions, one running across the base of the fingers and the other spanning from cell (0,12) to (18,12). All four corners and both existing fingers are slightly bent in toward Face A.

Face B also has a medium gray matte patina. There are several noteworthy recurring marks and symbols, including incised X's or T's, overlapping circles, and W's or M's made with the rockering crescent mark seen on some of the other aprons. There is an incised X near the fold in F3 (3,30), below F2 (15,27), and crosshatching or overlapping X's in cell (24,21). There are overlapping circular impressions with 20 mm diameters near the center of the apron in cell (15,18). Small circular depressions are scattered through cells (13,3) to (21,6).

There is a section of rockering marks in cell (18,18) that form a straight column approximately 5 mm wide and 20 mm long. Other areas with the rockering marks include cells (0,15) to (3,18) and cells (6,0) to (9,3), both of which resemble W's or M's. Close inspection of the symbols made with the "rockering" mark reveals that there may actually be two separate, but similar looking, types of this mark. The first type of mark, R1, is comprised of repeating crescents scored into the lead (Figure 18); the second type, R2, appears to made by overlapping V-shaped impressions (Figure 19). Areas on Face B with the R2 mark include cells (12,15) to (15,18) which resembles two X's inside rectangles, and cells (6,21) to (12,24) which does not form a discernible pattern. Other observations about Face B include a concave linear indentation beneath H1 (also visible on Face A), slight orange corrosion around F1 and F2, and distortion around the fastener holes that indicates marline was threaded under the center and over the edges of Face B.

FIGURE 18. Detail of R1 marking on QAR 1269.000 (Photo by author, 2011).

FIGURE 19. Detail of R2 marking on QAR 1269.000 (Photo by author, 2011).

Artifact Number: QAR 1391.000

Weight: 3830.0 g

Provenience: Unit 08/07 #104 E78.5 N42.5

Thickness: 3.0-5.5 mm

Length: 310 mm

Number of Fingers: 7

Width: 250 mm

XRF Data: No

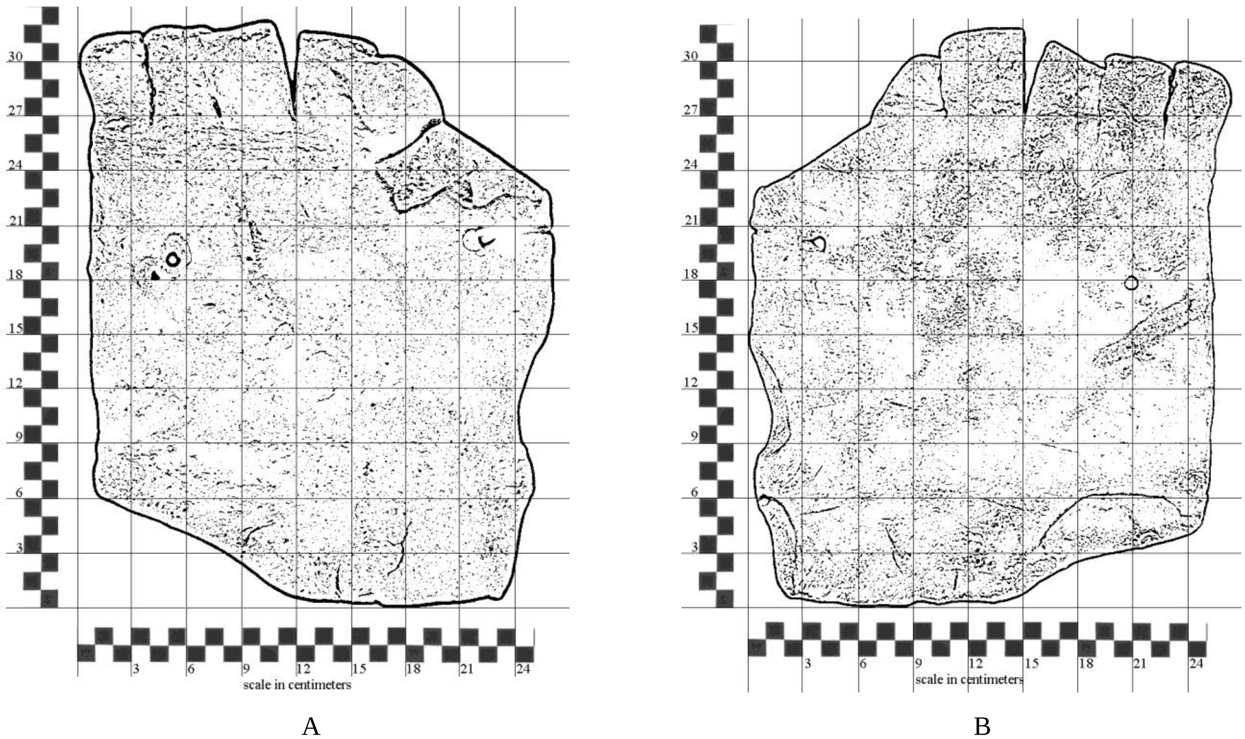


FIGURE 20. QAR 1391.000: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

This artifact (Figure 20) has seven existing fingers along Side 1 and no spaces for missing fingers. The edges of all four sides are rounded with a slight taper in the center. The fingers are all approximately 30-40 mm wide by 50 mm long. The edges of the fingers are all unifacial in cross-section except for those that face outward (F1d, F7b, and all "a" sides) which are rounded in cross-section. All fingers are curled in toward Face A to varying degrees. Unlike other aprons, this one has three circular fastener holes. H1 and H2 are each 10 mm in diameter and in typical locations, but H3 is 5 mm in diameter and located slightly below and to the left of

H1. H3 may have been a mistake. The cross-sectional edges of H1 and H3 are unifacial, but the cross-sectional shape of H2 is difficult to determine due to stretching. Slough lead around the edges of the fastener holes has been flattened against Face A.

Face A has few markings except for a swath across the center of the apron with tiny X's and cross hatching that resembles abrasion more than cultural markings. There is a linear indentation, concave on Face A, that spans the apron from cell (0,6) to cell (24,6) and another linear indentation from H2 to Side 2, which indicates marline was threaded over this edge. Face B has the same style X's and cross hatching visible on Face A. There are also circular depressions and pitting below F4 and F5, a repeating pattern of V shaped marks in cell (12,6), scoring that spans from (0,15) to (6,15), and an M or W shaped symbol in cell (18,9) comprised of the R2 marks seen on artifact 1269.000 (Figure 21).

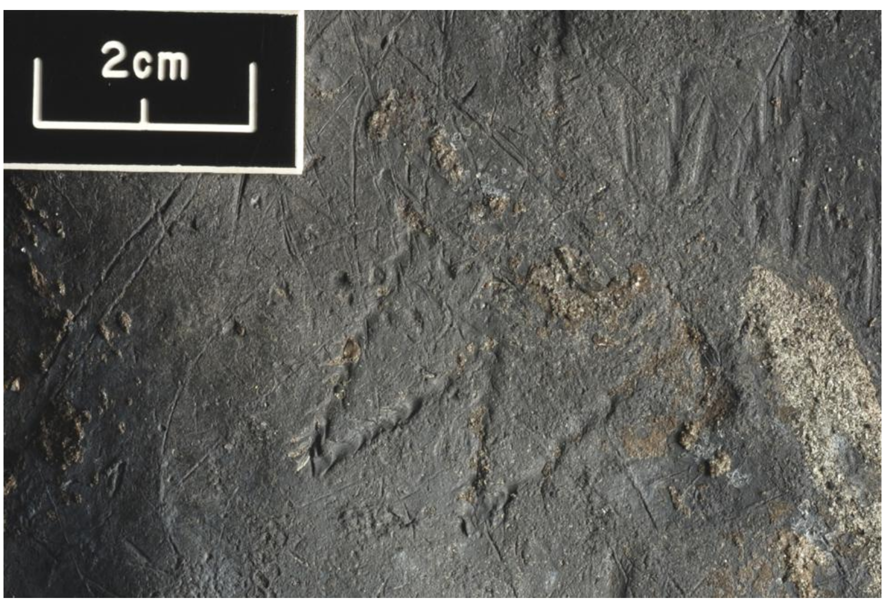


FIGURE 21. Detail of markings on QAR 1391.000 (Photo courtesy of NCDCR).

Artifact Number: QAR 3225.000

Provenience: Unit 10/08 #206 E70.5 N65.5

Length: 230 mm

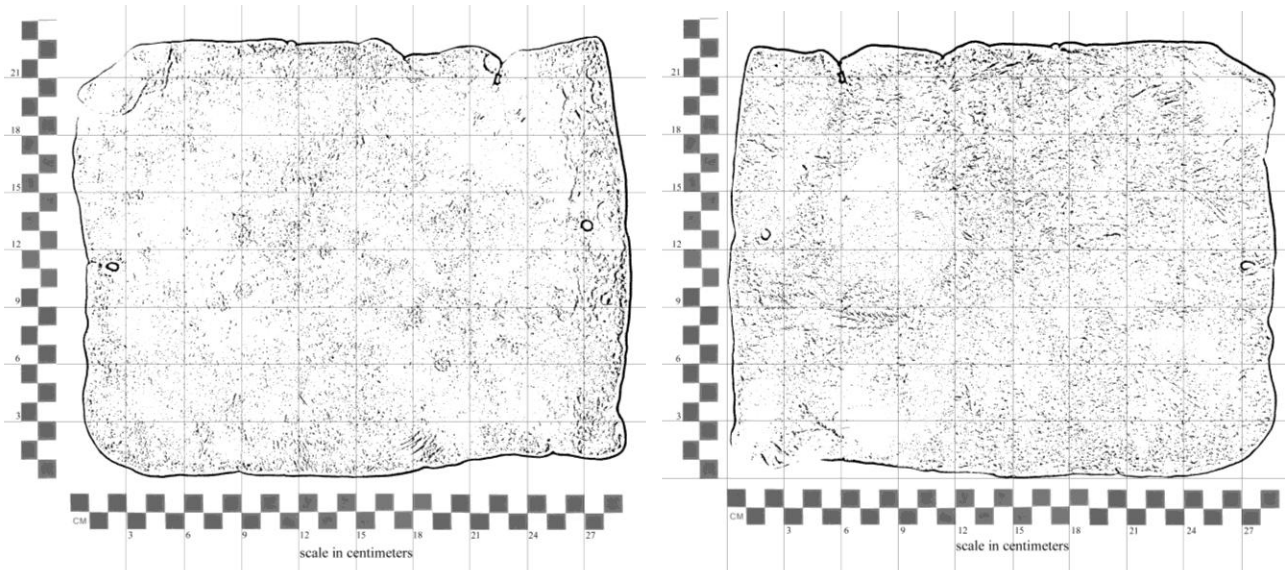
Width: 300 mm

Weight: 2060.5 g

Thickness: 2.5-3.0 mm

Number of Fingers: 4 partials

XRF Data: No



A B

FIGURE 22. QAR 3225.000: *(a)* Face A; *(b)* Face B. (Figures by author, 2011.)

At first glance, apron 3225.000 (Figure 22) appears to have no prominent fingers, but closer inspection reveals two along the left of Side 1 that have folded over onto Face A. Additionally, there are notches cut into Side 1 that may correspond to fingers that were cut away or only partially formed. The two fully formed fingers are difficult to measure because they are folded, but they appear to follow the 30 by 30 mm dimensions on other aprons. According to measurements between the notches in Side 1, the four cut away fingers were 60-65 mm wide, an anomaly. In contrast to other aprons, edges of all four sides of 3225.000 are rounded in cross-section. The edges are thinner than the others and almost tapered in appearance, but the metal does not seem heavily deteriorated. The edges of the fingers are also rounded in cross-section. The object has two circular fastener holes, each 8 mm in diameter with unifacial edges.

The apron has a light gray slightly mottled patina with patches of what appears to be stable white corrosion around some edges. On Face A there are several circular abraded patches, all approximately 8 mm in diameter, located in cells (6,9), (18,6), and (12,12). These are particularly interesting because they are unique to QAR 3225.000; no other aprons have marks of this type. Other markings visible on Face A are repeating gouges in cell (18,0). Overall, there are very few markings on this apron; its most prominent feature is a large circular depression (convex on Face A) approximately 70 mm in diameter. It spans cells (18,12), (18,15), (21,15), and (21,12).

The surface of Face B is more mottled than the obverse and has a few more markings. There is light scoring in cell (24,12), gouges in cell (24,15), and a slanted linear indentation in Side 3 (18,0) that could be the result of a chisel cut. The most noteworthy markings on Face B are repeating crescent shaped scoring or rockering (Figure 23). These marks are approximately 4-5 mm wide and located beneath the large circular depression in cells (3,9) and (6,6).

FIGURE 23. Detail of rockering on QAR 3225.000 (Photo by author, 2011).

Artifact Number: QAR 1513.000

Provenience: Unit 08/07 #95 E82.5 N37

Length: 225 mm

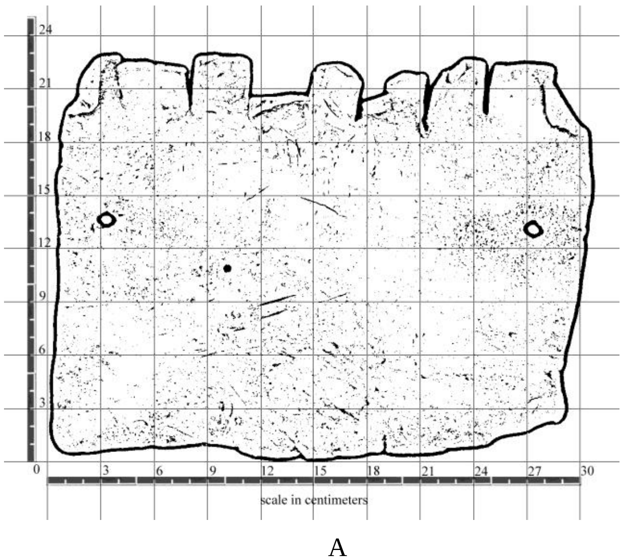
Width: 300 mm

Weight: 2265.4 g

Thickness: 2.5-4.0 mm

Number of Fingers: 9

XRF Data: Yes



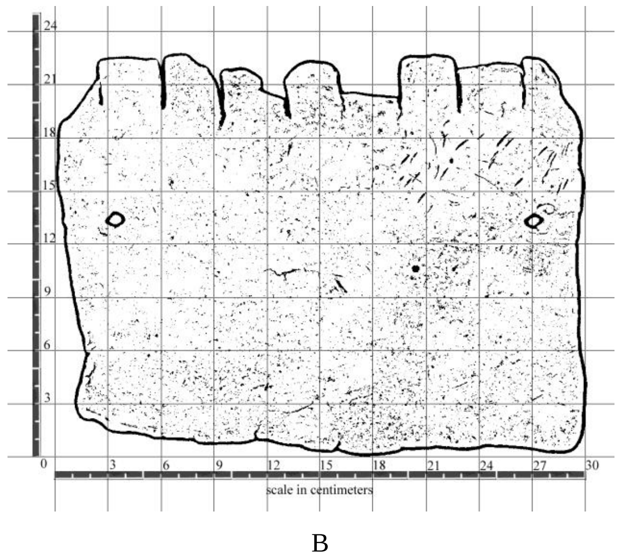


FIGURE 24. QAR 1513.000: *(a)* Face A; *(b)* Face B. (Figures by author, 2011.)

QAR 1513.000 (Figure 24) has nine existing fingers and no spaces for missing fingers. Sides 2 and 4 have edges with unifacial cross-sections. The fingers on this apron are not as uniform as on some of the others, but their dimensions are still within 5 mm (plus or minus) of 30 mm by 30 mm. About half the fingers' edges are rounded in cross-section and the other half are unifacial. There are two circular fastener holes that appear to have been stretched laterally with use. The original diameters are believed to be 10 mm each because that is the measurement from top to bottom (not stretched). The diameters measured from side to side, along the stretched axes, are 13 mm each.

Markings on Face A include cut marks that do not go all the way through the metal in cell (12,6), circular depressions 4-5 mm in diameter located in cells (18,9), (9,0), and (9,9), and two slanted linear indentations in the edges of Side 2 and one in Side 3. The surface of the lead around the fastener holes is pitted and abraded and there is a linear indentation from H2 to Side 2 that may have been caused by marline used to attach the apron.

On Face B there is a cluster of cut marks (all about 7-10 mm long) and small circular depressions in the top right corner beneath the fingers. Other markings on this face include a 10 mm long gouge in cell (15,9), a linear indentation between H2 and Side 2, and a large convex curve running across the bottom of the apron that could have resulted from a gun's base ring.

Artifact Number: QAR 1487.000

Provenience: Unit 08/07 #95 E84 N39

Length: 240 mm

Width: 295 mm

Weight: 2510.0 g

Thickness: 3.0 mm

Number of Fingers: 2

XRF Data: No

A B

FIGURE 25. QAR 1487.000: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

Artifact 1487.000 (Figure 25) has a unique finger pattern. The apron has only two existing fingers, located equidistant from each other along Side 1. Each finger is approximately 80 mm wide and only 15 mm long, which is drastically different from dimensions of other apron fingers. There are three spaces where fingers are missing, one to the left of F2, one between F2 and F4, and one to the right of F4. There are places along Sides 2 and 4 with unifacial cross-section edges, but for the most part the edges are rounded. Cross-sections of all finger edges are rounded and slightly tapered. There are two circular fastener holes, each approximately 10 mm in diameter. Both fastener holes are slightly distorted. The orientation of slough lead around the fastener holes on Face B indicates that marline would have been threaded over the center of the apron on Face A, through the holes, and under the edges.

The most prominent markings on Face A are X's inscribed in the upper left corner in cells (3,18) and (6,21). The surface of the lead is somewhat distorted and roughened in this region suggesting it may have been an attachment point for concretion. Faint orange corrosion in the area supports this interpretation. There appear to be markings similar to the incised X's in the top right corner, but this is difficult to determine with certainty because that portion is obscured by the large fold in the apron. Other markings include 6 roughly parallel lines scored beneath H1 and a large linear impression, concave on Face A, that spans the entire object in line with the fastener holes. An original orientation is hard to determine because the apron is currently folded, almost in half, in towards Face A, but it appears to have at one time had a curvature convex on Face A, suggesting that Face B was molded against the gun. Face B has fewer markings. There is no scoring but there are some gouges and irregular impressions, most notably in the areas between cells (3,15) to (6,18) and (3,12) to (6,12). The large linear impression noted on Face A is visible as a convex impression on Face B.

Artifact Number: QAR 543.000

Weight: 1540.0 g

Provenience: Unit 05/05 #02 E78 N111

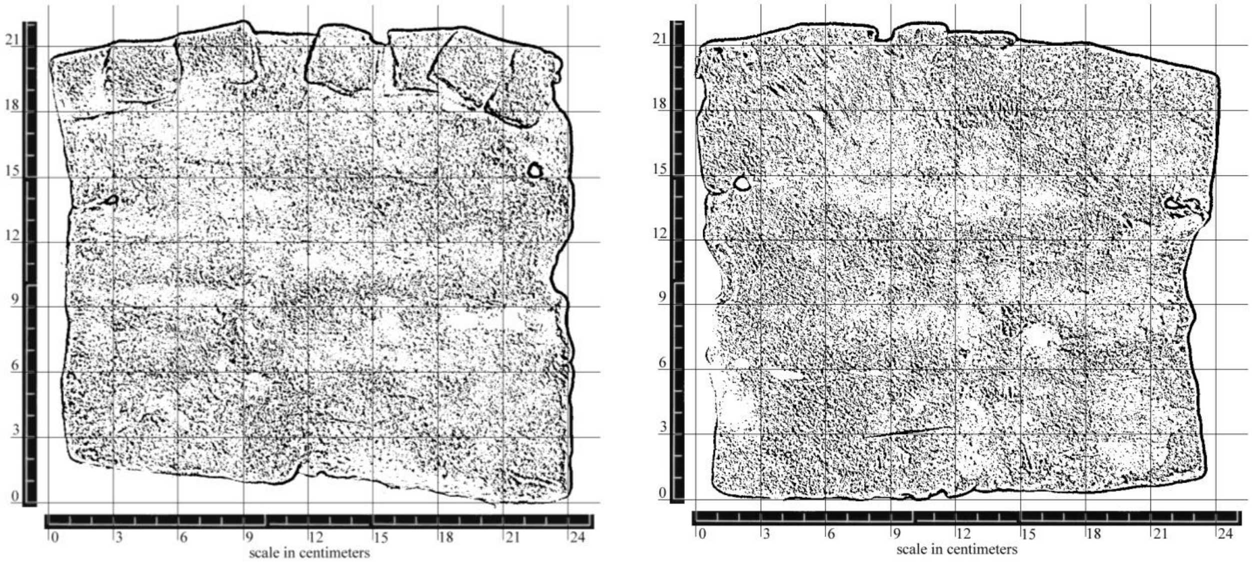
Thickness: 2.5 mm

Length: 230 mm

Number of Fingers: 7

Width: 230 mm

XRF Data: No



A B

FIGURE 26. QAR 543.000: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

This apron (Figure 26) is 230 mm wide by 200 mm in length with 7 existing fingers along Side 1 and one space for a missing finger. The cross-section edges of all four sides are rounded. The finger dimensions are all approximately 30 mm by 30 mm and all are curled in toward Face A. There are two circular fastener holes, each approximately 10 mm in diameter. H2 has a very clear unifacial cross-section edge but H1 is difficult to determine due to stretching and a tear toward Side 4. This wear suggests extensive use.

QAR 543.000 is more corroded than other aprons in the collection. It has a light gray patina speckled with white patches. There are very few surface markings or they may be obscured by the white corrosion. The only notable mark on Face A is a large convex indentation below H1 that spans the whole artifact. Face B has the same patina and also has very few markings. There is a cut mark in cell (9,3) and a discoloration in cell (9,15) that may correspond to pre-treatment concretion.

Artifact Number: QAR 1574.000

Provenience: Unit 09/07 #95 E84.5 N38.5

Length: 295 mm

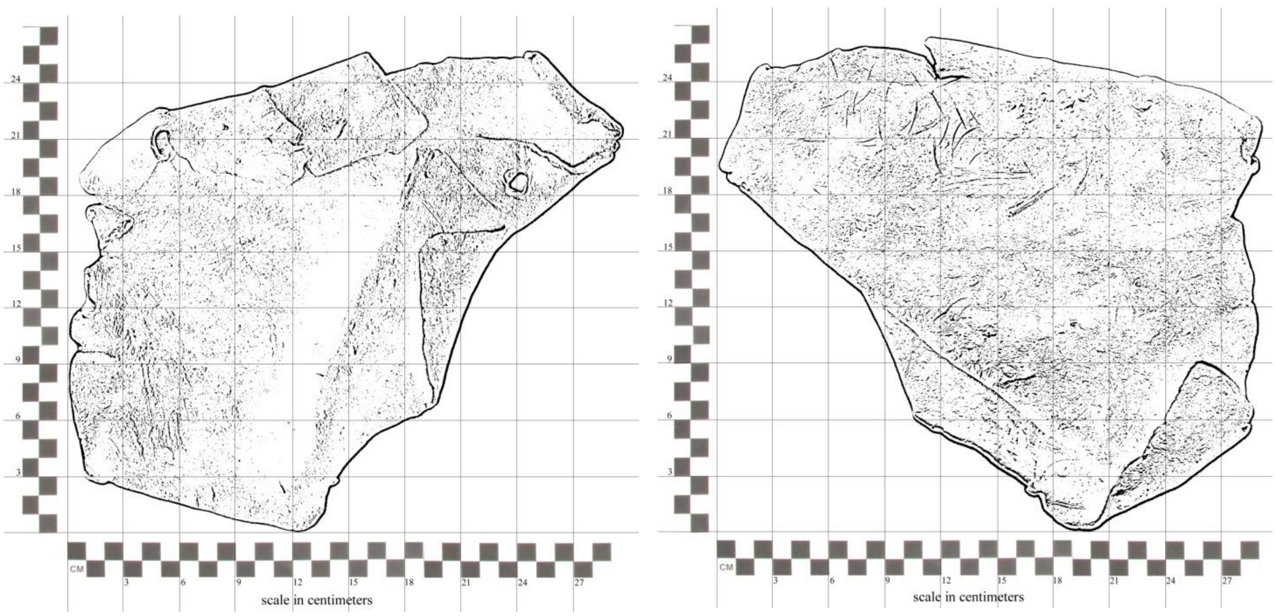
Width: 315 mm

Weight: 2660.0 g

Thickness: 2.0-3.5 mm

Number of Fingers: 7

XRF Data: No



A B

FIGURE 27. QAR 1574.000: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

Artifact 1574.000 is perhaps the most unique among the QAR aprons and one of the most difficult to record due to folding (Figure 27). It is a 300 by 300 mm lead square with finger-like tabs, but for the most part, the similarities to other aprons end there. The cross-sectional edges of all four sides are rounded and slightly tapered. There are two sets of fingers, one along Side 1 and one along Side 4. The set along Side1 includes three existing fingers (approximately 60 mm wide by 70 mm long) and one large 135 mm wide space where fingers are missing. The set along Side 4 includes four existing fingers of varying dimensions (F6 is 55 by 25 mm, F7 is 70 by 20 mm, and F8 is 45 by 15 mm) and no spaces for missing fingers. Most of the fingers' edges are rounded in cross-section. 1574.000 has only one circular fastener hole measuring 15 mm in diameter with a unifacial cross-section.

This artifact has an evenly distributed matte gray patina and only a few markings visible on Face A. These markings include small areas of pitting around the edges of the object, linear abrasions in the lower left corner (3,3), a large convex curve or indentation that spans the object in line with H1, a concave indentation in cell (9,6), and 4 mm wide crescent shaped depressions in that concave indentation, a crack through the lead in cell (12,6), 3 mm wide push/drag marks in cell (3,9), and a short deep linear indentation in cell (9,0). There is also scoring on the lower right corner in cell (18,12), but it should be noted that these markings are actually on Face B and only visible on the Face A grid due to folds in the lead.

Face B is marked more heavily. There are rounded push marks of varying sizes in cells (15,21), (18,21), and (21,21), shallow linear scrapes in the lower right corner and in cells (12,18), (15,18), and (24,18), and at least a dozen short, slightly curved cut marks in the upper left corner. The crack in the lead mentioned for Face A appears, from this side, to be two adjoining stab marks, each 10 mm in length. From this side, it is also evident that F3 is partially cut at the base along F3c (12,24). The large convex indentation noted on Face A is visible on Face B as a concave indentation spanning the object at the 15 cm grid mark. There are also slanted linear indentations in the edge of Side 3.

Artifact Number: QAR 1497.000

Weight: 2788.9 g

Provenience: Unit 08/07 #95 E82.5 N37

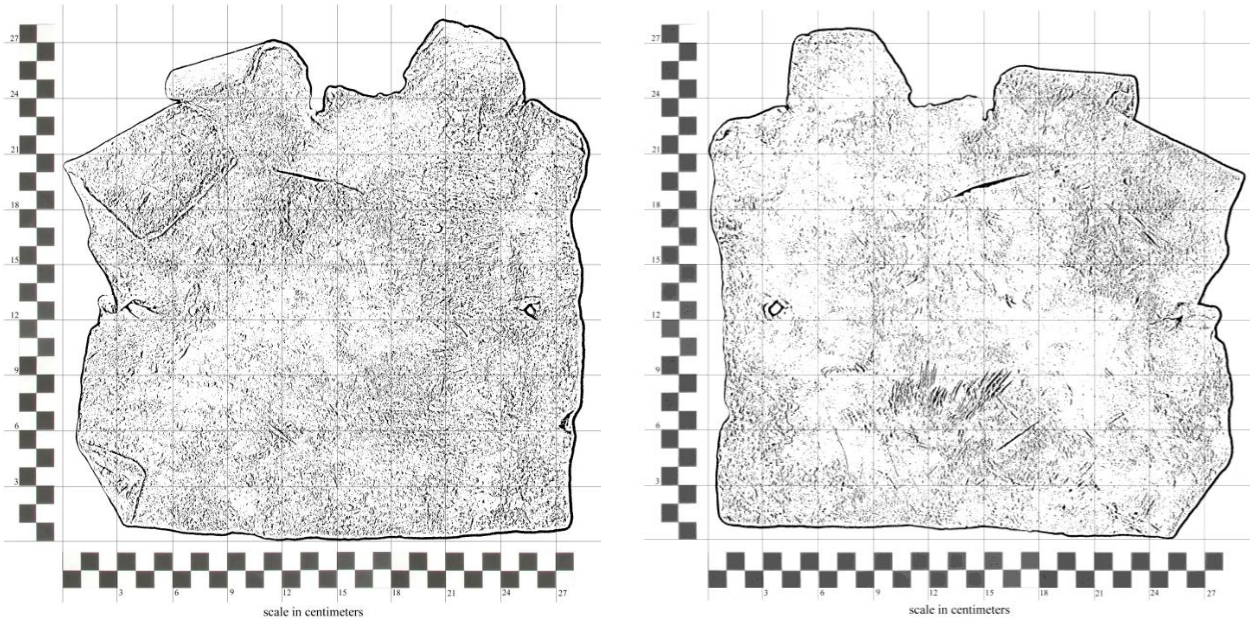
Thickness: 3.0-3.5 mm

Length: 290 mm

Number of Fingers: 5 (1 detached)

Width: 290 mm

XRF Data: Yes



A B

FIGURE 28. QAR 1497.000: *(a)* Face A; *(b)* Face B (Figures by author, 2011).

QAR 1497.000 (Figure 28) has three existing fingers and two spaces for missing fingers. All four sides of this object have unifacial cross-section edges. One of the two missing fingers, F3, was attached when excavated but subsequently broken off during treatment. Though detached from the apron, F3 is available for study and its dimensions are included in this documentation. The three attached fingers are approximately 70 mm wide and have varying lengths (60 mm, 80 mm, and 40mm). F3 and MF5 are slightly narrower with widths of about 40 mm. The apron has two fastener holes each approximately 10 mm in diameter. The holes apprear to have been circular at one point but are now somewhat distorted, H1 is pinched together by a fold in the metal.

The artifact has a medium gray semi-matte patina. There are several areas of pitting and deterioration on Face A, most notably in the bottom right corner (24,0). There is a linear abrasion covering most of Face A, running across the object from Side 4 to Side 2. The abrasion is faint but could be an indication of having been dragged over a rough surface. There is a cut mark all the way through the lead between cells (12,18) and (15,18). The cut is approximately 45 mm in length with unifacial edges. There is another cut mark in cell (12,6) that appears to have gone all the way through the metal and then been smoothed over on Face A.

Face B has the same patina and the same deterioration/delamination in the lower left corner but has significantly more markings than Face A. The smoothed over cut mark noted on Face A is more visible on the reverse side; it is approximately 30 mm in length with unifacial edges. There is a cluster of shallow cut marks in cell (15,6) that have V shaped cross-sections and average 15-20 mm in length and 1 mm in depth. There are also nearby clusters of gouges. This apron has much shallow scoring on Face B. Of particular interest are several groups of score marks that radiate out from a single point in a fan shape (Figure 29). These formations are located in cells (0,18), (3,18), and (3,15). The marks that make up these fan shaped formations are very thin (about .25 mm) and their cross-sectional shape is indeterminate. Another interesting formation of scoring is located beneath MF5 near cell (0,21). The lines are thin, like those in the fan formation, and they form two overlapping V's or a W or an M shape overlaid with crosshatching. There is also a formation between cells (6,3) and (9,3), comprised of wider score marks (0.5 mm) with U shaped cross-sections, that make a grid formation. Other marks on

Face B include a 10 mm wide gouge or push mark in cell (9,12), and a linear abrasion/depression that spans cells (6,9), (12,9), and (15,9).

FIGURE 29. Detail views of fan shaped markings on QAR 1497.000 (Photos by author, 2011).

CHAPTER 8: INTERPRETATION AND DISCUSSION

Introduction

Apron characteristics will now be discussed in terms of what they reveal about how the QAR aprons were used and the behavior of the people who used them, with the intention of filling in gaps left by historical documentation. One integral and challenging step in this interpretation was distinguishing between culturally significant marks and incidental marks. The Behavioral Archaeology model was used to help make these distinctions by identifying apron characteristics caused in the archaeological context and classifying them as either c-transforms or n-transforms. The remaining characteristics were presumably caused in the systemic context and were interpreted with the aid of Schiffer's (1995:27-28) life processes of a durable element.

Behavioral-Material Correlates

Correlates linking specific tools to certain types of markings in lead would be extremely useful for the purposes of this project, but there is little previous research on this topic. Experimental archaeology was used in an attempt to lay the groundwork for these correlates, but was only partially successful. Behavioral-material correlates were identified for shears cut marks, hammer/chisel cut marks, and air scribe marks but most of the marks could not be linked to a specific action or behavior. The lead's softness makes it possible for a variety of tools and actions to result in the same type of mark.

Though little previous research was found relating specifically to tool marks on lead, information was located pertaining to tool marks on other metals such as bronze and pewter. In attempts to establish a descriptive terminology of Iron Age bronze working techniques, Prehistoric Society archaeologists used experimental methods to identify marks made with four tools: the scriber, graver, scorper, and tracer (Lowery et al. 1971:167). All four were used in the

Iron Age but, as Lowery (1971:169) points out, "the principal ancient small tools are likely to have been largely identical with…modern counterparts." The marks produced in this experiment are incredibly similar to marks found on the QAR aprons. It is reasonable to assume that the behavioral-material correlates linking certain bronze surface markings to certain tools and motions may be similar to behavioral-material correlates for lead surface markings. By this logic, the R1 marks found on aprons 1269.000 and 3225.000 most closely resemble marks made by rolling a round-nosed graver across a metal surface (Figure 30*a*). The R2 marks found on aprons 1269.000 and 1391.000 resemble rocked lines made with either a pointed-oval graver or a common graver (Figure 30*b*, *c*).

A B C

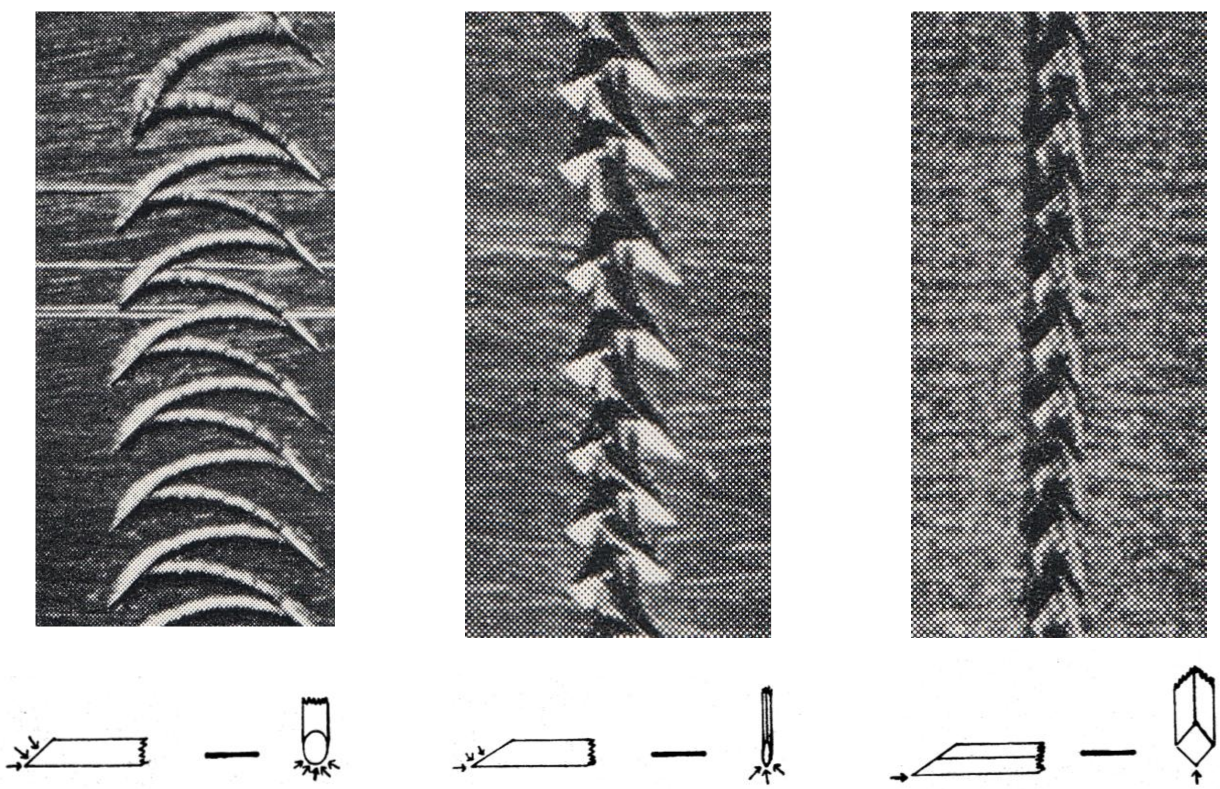


FIGURE 30. Bronze working marks and tools: *(a)* rolled round-nosed graver mark; *(b)* rocked pointed-oval graver mark; *(c)* rocked common graver mark (Lowery et al. 1971:171,Plate X,Plate XII).

C-Transforms

The primary C-transforms at work on the QAR aprons are the manner of their deposition into the archaeological record, excavation processes, and conservation treatments. *Queen Anne's Revenge* is believed to have been purposely run aground, as opposed to accidentally run aground or lost in a storm (Lee 1974; Wilde-Ramsing 2009). Human activity caused the vessel, and therefore the aprons, to be deposited into the archaeological record which classifies the process as a cultural transform. This transform, however, is more relevant to the QAR site formation process and less so to the present material culture study.

The next c-transform to affect the aprons was excavation and recovery. While every effort was made to ensure that no artifacts were damaged during the recovery process, due to the malleability and softness of lead, it is probable that one or more aprons were scratched, dented, or otherwise marked, during excavation and transport. No major incidents were reported, but small markings could have occurred without notice. It was not possible to determine with certainty that any markings on the QAR aprons were a result of excavation processes, but it is important to note that it has not been ruled out.

Conservation treatments, the final c-transform investigated by this study, have had a more measurable effect on the aprons, as evident from before and after treatment photos (Figure 31*a*, *b*). In stabilizing the artifacts, conservators used a variety of chemical and mechanical methods to remove corrosion and concretion from the aprons. Depending on in situ proximity to iron artifacts, some aprons were far more heavily concreted than others and therefore needed more rigorous treatments. Based on treatment records, pictures, and the cleaning of QAR 1321.001, which had several areas of very stubborn concretion, it is possible to say with some certainty that conservation efforts caused some marks and characteristics, however slight, on the aprons. The first characteristic caused by conservation is the matte dark gray patina present on most aprons. This patina is a result of the sodium sulfate rinse and gentle scrub the aprons receive after the acid baths. It is beneficial to lead artifacts because it creates a semi-passivating layer over the lead that protects it from further corrosion; it is also aesthetically beneficial for museum display.

A B

FIGURE 31. QAR 1104.001: *(a)* before treatment; *(b)* after treatment (Photos courtesy of NCDCR).

Another characteristic present on some aprons that could be caused during conservation is discoloration from acid etching. During treatment of QAR 1321.001, poultices of 10% hydrochloric acid were used in addition to acid baths to break up patches of concretion. It was believed that this would be less damaging to the soft lead surface than mechanical cleaning. The treatment was partially successful but locations where poultices were applied are now slightly more etched than the rest of the surface and the lead is a much lighter gray. The discolorations cannot be darkened with the sodium sulfate rinse.

The final apron characteristic that can be ascribed to conservation treatments is marking from mechanical cleaning. The treatment of QAR 1321.001 involved alternating chemical cleaning with mechanical air scribe cleaning. There were several instances when the air scribe came into contact with the apron's surface; this was undesirable except that it did provide a correlation between a specific type of a mark and a specific behavior. The air scribe made a small distinct gouge in the lead surface, a mark that was noted on several other aprons. This indicates that the same markings found on other aprons are the result of c-transform air scribing.

N-Transforms

The main N-transforms at work on the QAR aprons include corrosion of lead in seawater, concretion from contact with iron artifacts, and the post-depositional distribution of artifacts due to natural causes like water movement and coastal storms. Lead corrosion seems to have had a minimal effect; most aprons are in a fairly good state of preservation with the exception of some minor surface pitting (Figure 32). Concretion itself is an n-transform, but its removal is a c-transform as discussed above. With regard to post-depositional artifact distribution, some aprons have small circular depressions or divots that are too large and too uniform to be pitting from corrosion (Figure 33). Conservation records revealed that one apron was reported as having several pieces of Rupert method shot concreted to the surface and that when the shot was removed in cleaning, it left divots in the surface. Other records made no mention of concreted shot, but pre-treatment photos (Figure 34) revealed that most aprons with the same circular depressions had Rupert shot removed during cleaning. The small circular divots were caused by post-depositional distribution and can therefore be considered effects of n-transforms.

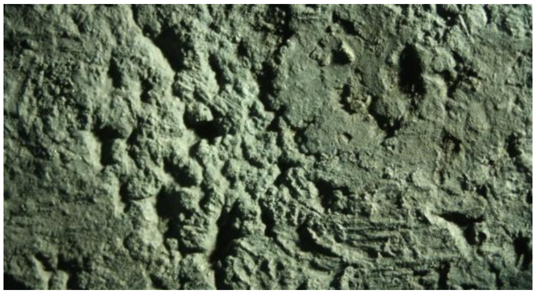


FIGURE 32. Detail of pitting on QAR 1513.000 (Photo by author, 2011).

FIGURE 33. Detail of Rupert shot divot on QAR 1486.000 (Photo by author, 2011).

FIGURE 34. Pre-treatment photo of QAR 1497.000 and adhering lead shot (Photo courtesy of NCDCR).

Life Processes of a Durable Element

Overall, relatively few characteristics have been explained above as part of the aprons' archaeological context. Presumably this means that the remaining characteristics are part of the objects' systemic context. This is obviously not the case since it was not possible to identify all types of marks with behavioral-material correlates. Some of the remaining characteristics could be results of n-transforms or c-transforms not yet identified. Though not comprehensive, the application of Behavioral Archaeology theory has eliminated *some* apron characteristics as distortions caused by their archaeological context. The characteristics believed to represent the systemic context are interpreted below within the framework of Schiffer's "life processes of a durable element." The "maintenance" and "discard" processes have been omitted because they have not been linked to any apron characteristics thus far.

Procurement

It was hypothesized in Chapter 1 that analysis of the aprons would allow them to be sorted into categories based on dimensions. Aprons have been classified according to their dimensions at other points in time because dimensions correspond to the type of gun on which they were used (Smith 1779:9; Adye 1813:2; Blackmore 1976:218). This hypothesis was disproven, however, as analysis of the collection revealed the aprons to be too dissimilar to determine categories based on dimensions; none are exactly the same size (although some are close). Neither are all fastener holes in the same precise locations, nor are all fingers the same size and shape. Historical documentation indicates that aprons, and artillery in general, were becoming more standardized for naval use by the 18th century, but there is no indication that non-naval vessels followed the same standards (Povey 1702; Smith 1779). Only two aprons, 1391.000 and 1498.000, fit dimensions specified in later 18th century manuals. Both measure approximately 12 inches x 10 inches, which is the apron size designated for 18, 12, and 9 pound guns (Smith 1779:9).

The fact that the QAR aprons are dissimilar suggests that they were not procured in prefabricated form, as items from naval stores, but were manufactured onboard as needed. This is the same conclusion reached by historians and archaeologists examining *Whydah* material culture who describe aprons from that collection as having very little uniformity and appearing "homemade" (Ken Kincor 2011, pers. comm.). Sheet lead was a typical part of 18th century ships' stores because it was used for hull patching, so the material to manufacture an apron would have been available to most gunners (Povey 1702).

Manufacture

The method of manufacturing the QAR aprons was exceedingly difficult to assess because they appear so simply constructed. They are all one piece objects made of a single material. They could likely be made using very few tools and no plans, drawings, or instructions, as is evident from the lack of information detailing apron construction in 16th, 17th, and 18th century gunner's manuals (Tartaglia 1557; Smith 1627, 1691; Bourne 1643; Eldred 1646; Nye 1647; Roberts 1668; Binning 1677; Seller 1691; Moretti 1673; Povey 1702; Tousard 1809; Simmons 1812). Hypotheses for how the aprons were manufactured originally included the possibilities that they were cast from molds or cut from sheet lead. After preliminary artifact inspection and in consideration of the fact that casting each apron would be too labor intensive for such a ubiquitous object, this hypothesis was omitted. Assuming aprons were cut from sheet lead, the next question was how they were cut. The two most plausible options are that they were either cut with shears or with a hammer and chisel, tools that gunners would have access to. Experimental archaeology was used to determine how cut marks made with these tools could be distinguished from one another. Sheet lead cut with shears has a bifacial cross-sectional edge whereas sheet lead cut with a hammer and chisel has a unifacial cross-sectional edge. No QAR aprons displayed a distinct bifacial cross-sectional edge, but many showed unifacial edges. It was unexpected to find so many edges that were rounded in cross-section. At first, this edge was assumed to be the result of post-depositional wear and lead corrosion. Eventually this interpretation came into question because most aprons are in a good state of preservation. If some of the most delicate surface markings remained intact after 300 years under water, so too should the edges' cross-sectional shape. This suggests that rounded edges were most likely an intended part of the manufacturing process. The majority of the aprons in this assemblage are rounded on the outside edges (Sides 2, 3, and 4) and on the tops of the fingers (Side 1) but the edges between most fingers are unifacial. It seems probable that the outside edges may have been filed and the corners rounded as a safety precaution for the gun crew. The inside edges of the fingers may not have been filed because they were not exposed and therefore not a hazard. Files were standard parts of gunners' tool kits in the 18th century so this hypothesis is not unreasonable (Eldred 1646:106).

Use

Primary Function Use

As hypothesized in Chapter 1, if the QAR aprons were used according to historical descriptions, their proveniences on site should correspond to gun locations. The QAR site is not yet fully excavated but locations of all guns are known because they were mapped during gradiometer surveys described in Chapter 5. More aprons may yet be recovered, but plotting the known apron proveniences will tentatively determine whether or not they correspond to gun locations. The 2010 QAR site map, overlaid with green dots to represent apron proveniences (Figure 35), reveals the beginnings of a pattern. Nine aprons were found in the southwest end of the site in close proximity to nine guns. Two other aprons were found outside this cluster; one in the northwest end closely corresponds to cannon C-24. To date, no aprons have been recovered in proximity to the main ballast pile near the center of the site where there is another cluster of 11 cannon. It seems likely, based on the emerging pattern, that continued excavations will reveal aprons in close proximity to guns in the main ballast pile.

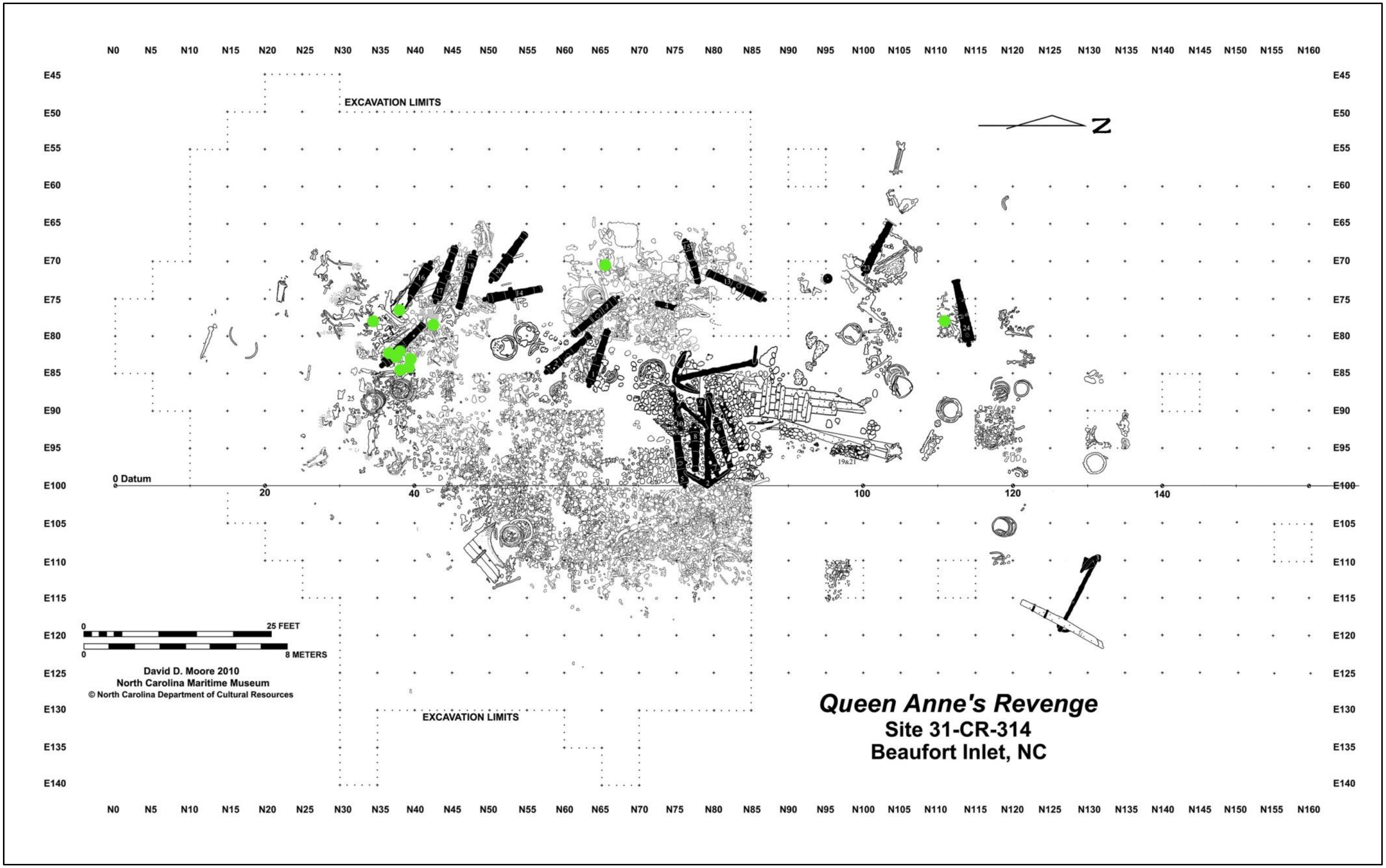


FIGURE 35. 2010 QAR Site Plan, apron locations marked in green (Map courtesy of NCDCR, amended by author 2011).

Other primary function interpretations of the QAR aprons pertain to their use-life orientation. It seems possible to determine an apron's orientation during its use-life (which side was face up and which side was molded to the gun) based on certain characteristics recorded on the cultural analysis forms. These characteristics include the direction in which the fingers are bent, curvature of the apron, slough lead around fastener holes, and the location of most markings. Aprons are meant to be molded to a gun's vent field with the fingers presumably folded securely over the breech. It is therefore reasonable to assume that an apron found with its fingers curled down toward Face B, and a general concave curvature on Face B, was positioned during its use-life with Face A up and Face B against the gun's surface. Using this same example one could assume that slough lead around fastener holes would be flattened on Face B and that there would be more markings present on Face A. It must be remembered, however, that lead is a malleable material and an apron's shape could be altered during the wrecking process or during its post-depositional life, so none of the aforementioned characteristics is definitive proof of use-life orientation. The fewer characteristics present on an object obviously means the less convincing any claim for use-life orientation. Conversely, if all characteristics are present, a fairly strong case can be made to determine the object's use-life orientation.

Artifact 1391.000 (Figure 36) for example, exhibits three specific characteristics. The fingers are all bent in towards Face A to varying degrees, slough lead around H1, H2, and H3 is flattened against Face A (Figure 37), and there are far more markings on Face B. These configurations indicate that this apron was used with Face A against the gun and Face B up.

FIGURE 36. QAR 1391.000 fingers curled in toward Face A (Photo courtesy of NCDCR).

FIGURE 37. Slough lead flattened on Face A around QAR 1391. 000 fastener holes (Photos courtesy of NCDCR).

These guidelines are not always helpful; sometimes there are characteristics present on the apron that contradict each other. Artifact 1498.000 for example, has fingers curled in toward Face A, indicating a use-life orientation with Face A against the gun, but it also has more markings on Face A, which should indicate a use-life orientation with Face B against the gun.

Investigation of fastener holes was also useful in determining how often each apron was used and how they were attached to the guns. On many aprons, distortion in the lead around the fastener holes indicates the holes were originally circular and then elongated to varying degrees sideways. Typically the edge of H1 is stretched toward Side 4 and the edge of H2 toward Side 2. This stretching is sometimes accompanied by a tear as with aprons 1498.000 and 1269.000. Almost all aprons in the QAR collection have linear indentations or grooves running between the fastener holes and from the fastener holes to the nearest edge. Historical accounts confirm that aprons were attached to guns with marline, but they do not detail how (Smith 1779:9; Adye 1813:2). It is reasonable to assume that linear indentations and stretching near the fastener holes were caused by pressure from the marline and that the nature of these distortions offers insight as to how the marline was threaded around the aprons. Object 1498.000 for example, has a concave linear indentation on Face B, running from H1 to Side 4 (Figure 38), and a shallow crease on Face A arced between the fastener holes (Figure 39). The combination of these markings indicates that marline was threaded between H1 and H2 on Face B and out over the edges of Sides 2 and 4 on Face A. Similar claims can be made for objects 1487.000, 1497.000, 1269.000, and 1513.000. The absence of this distortion is equally noteworthy. It is likely that certain objects, such as 3225.000, were used very little, if at all, due to a lack of abrasion and distortion around H1 and H2.

FIGURE 38. Detail of linear indentation on QAR 1498.000 Face B between H1 and Side 4 (Photo courtesy of NCDCR).

FIGURE 39. Crease between H1 and H2 on QAR 1498.000 Face A (Photo courtesy of NCDCR).

Another characteristic shared by many QAR aprons is the wide linear depression/impression running across the object below the fastener holes. The depressions are visible on both the obverse and reverse sides approximately two thirds of the way below the base of the fingers. These depressions locations roughly correspond to the locations where the aprons would have covered a gun's base ring and vent astragal. An explanation for these marks, therefore, is that they were formed during the objects' use-life as part of their primary function, when the aprons were pressed into place around the associated guns' vent fields. Aprons 543.000, 1487.000, 1497.000, and 1574.000 all have potential base ring/vent astragal impressions.

Base ring depressions are a fairly common characteristic among cannon aprons. They occur in the QAR assemblage and from other sites and other time periods as well. Aprons from the Alderney Wreck, *Dartmouth*, Scallastle Bay Site (Figure 40), and *De Braak* (Figure 41) also have base ring depressions. The marks are so clear on the Scallastle Bay apron that archeologists were able to determine the size of the gun on which it was used:

> The compound curve around the vent-cover's basal part, where any distortion would be obvious, defines the almost true arc of a circle 42cm in diameter, measured on the inside. This may be taken to represent the diameter of the gun's breech ring...The 42cm base ring diameter of the Scallastle Bay cover closely matches the 16.65in (41.91cm) diameter base ring specified for a long 9-pounder in a table of dimensions for Blomefield guns cast at Carron for the British government in 1796 (Colin Martin and Philip Robertson 2011, pers. comm).

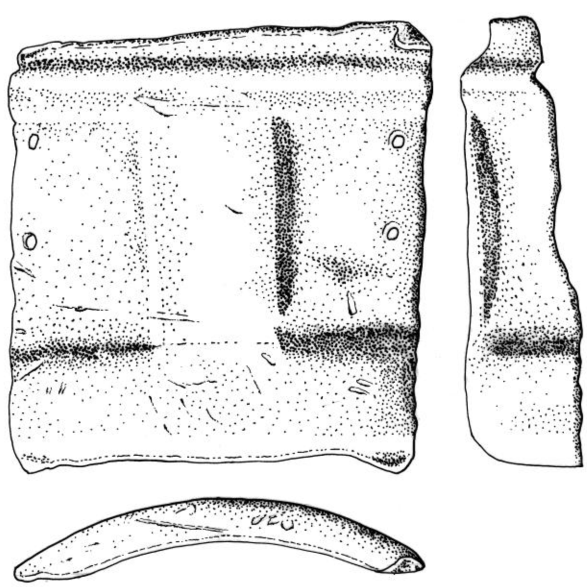


FIGURE 40. Scallastle Bay apron with base ring impression (Drawing courtesy of Colin Martin).

FIGURE 41. *De Braak* apron with base ring impression (Photo by author, 2011).

An illustration (Figure 42) of finds from the *Dartmouth* site shows how a lead apron was molded to fit snugly over a gun's base ring. Unfortunately no aprons from the QAR assemblage have clear enough base ring impressions to be able to determine the gun's original diameter.

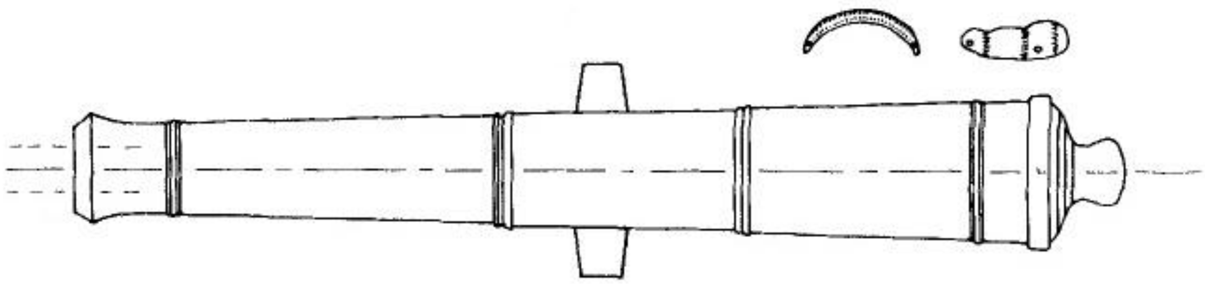


FIGURE 42. *Dartmouth* 9-pound demi-culverin and apron (McBride 1976:195).

Secondary Function Use

The interpretations above focus on specific aspects of the aprons' form and how those aspects relate to their intended use or primary function. One of the most interesting things about the QAR aprons, however, is that they are covered with markings which are not all explained by their primary function. Developing a systematic way to record these markings was a challenge, but an even bigger challenge lay in interpreting them.

The most intricate markings are made using "rockering," or a repeating series of crescent lines which has been incised in the surface of the lead to form a pattern or symbol. A similar mark, known as "wrigglework," was used to decorate pewter in the 17th and 18th centuries (Carnes-McNaughton 2011, pers. comm.). Wrigglework reached the height of its popularity between 1680 and 1710, which closely coincides with the dates of operation for *La Concorde*/*Queen Anne's Revenge* (Winslow 1998:29; Brett 1982:29). On two QAR aprons, (1269.000 and 1391.000) wrigglework-like marks form symbols which resemble M's or W's. A third apron (3225.000) has wrigglework that forms no recognizable symbol. It is possible that one or several members of the QAR crew were familiar with this pewter decoration technique and decided to practice on the soft surface of the aprons.

Further investigation of the marks revealed striking similarities to ritual marks carved into architectural timbers of 17th and 18th century English homes (Easton 1997, 1999). These marks, called apotropaic symbols, are used “to ward off the feared powers of the devil or witches” and are most commonly found around entryways like door jambs, windows, and hearths (Easton 1997:533, 1999:23). Fear of witches was common for many centuries in England, not just among common people, but among high ranking members of the clergy and the government also. In 1604, James I published a treatise on witchcraft called *Daemonologie,* in which he warns against witches’ familiars gaining entry to homes and churches by way of any unprotected thresholds (Easton 1999:22). This publication undoubtedly influenced the English people and may be partially accountable for the abundance of ritual marks above entryways in homes and churches.

Circles with petal-like formations inscribed within their borders, called hexafoils, are ritual marks commonly found in English vernacular architecture (Figure 43). Other than the overlapping circles on artifact 1269.000 (Figure 44), there are no markings on the QAR aprons that resemble hexafoils. Other easily recognizable apotropaic symbols are those meant to invoke protection from the Virgin Mary (Easton 1997:533, 1999:22-28). These include M’s, for Mary (Figure 45); W’s, which are actually interlocking V’s for Virgo Virginium (Figure 47) or inverted M’s; R’s, for Regina; and formations of lines radiating out from a single point, which are thought to be stylized M’s (Figure 49). Hourglass/butterfly symbols are also found (Figure 51), not as a Marian invocation but as a general charm to ward off evil (Easton, 1997:534). Marks similar to all of these can be found on the QAR aprons (Figures 46, 48, 50, and 52)).

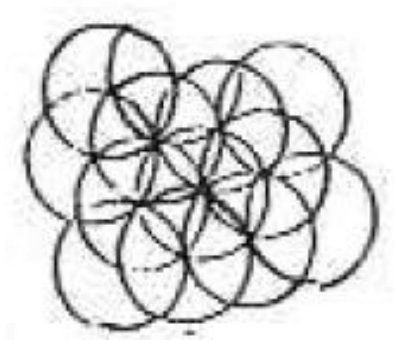


FIGURE 43. Hexafoil (Easton 1999:23).

FIGURE 44. Overlapping circles on QAR 1269.000l (Photo courtesy of NCDCR).

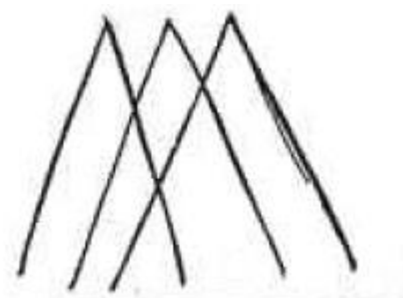


FIGURE 45. Overlapping “V’s” (Easton 1999:24).

FIGURE 46. Overlapping “V’s” on QAR 1497.000 (Photo by author, 2011).

FIGURE 47. Apotropaic “W” and “M” (Harris 1999:29).

FIGURE 48. “W” or “M” on QAR 1391.000 (Photo courtesy of NCDCR).

FIGURE 49. Stylized “M’s” (Easton 1999:26).

FIGURE 50. Stylized “M’s” on QAR 1497.000 (Photo by author, 2011).

FIGURE 51. Hourglass or butterfly symbol (Easton 1999:28).

FIGURE 52. Hourglass or butterfly symbol on QAR 1269.000 (Photo courtesy of NCDCR).

Apotropaic markings were used by a variety of tradesmen, including blacksmiths, carpenters, and farmers, and were often made with common implements like dividers or race knives (Easton 1997:534). Their specific purpose through Marian invocation was to give "protection to the craftsmen and their work," to act as a "consideration to a building undergoing major changes," and to give the "occupier…additional personal protection" (Easton 1997:534). Though Easton's research is based in vernacular architecture, there is no reason it cannot be applied to a maritime context. Mariners are a notoriously superstitious group. There are hundreds, if not thousands, of beliefs and customs that ensure safety at sea (Beck 1996; Jeans 2004). Most of these customs classify as taboos and dictate what *not* to do or have aboard. Several examples of these taboos include not having women or umbrellas aboard, not whistling during a fair wind, not killing an albatross, and not having priests or clergymen aboard (Jeans 2004:312-313,319,323). Though not as numerous as the taboos, there are a significant number of maritime customs that pertain to obtaining good luck, as opposed to avoiding bad luck (Beck 1996:363). Some of these customs include placing a coin under the mast, carving a star into the end of a bowsprit, and carrying a wren's feather for protection from drowning (Jeans 2004:306,310,324).

It seems possible in light of these superstitions and in consideration of occupational hazards that 18th century gun crews would have their own rituals and customs pertaining to their weaponry. Collaborative evidence of such practices is hard to come by, but not nonexistent. Historians have identified apotropaic symbols etched into the glaze of creamware from the *De Braak* site (Charles Fithian 2011, pers. comm.). The creamware is believed to have been issued to the crew, as finer tableware recovered from the site is thought to have been used by the officers, and implies a level of superstition inherent in foodways of the British Navy (Charles Fithian 2011, pers. comm.).

Another potentially related practice, though not involving apotropaic symbols, was discovered by historians of the USS Constitution Museum relating to a bible in the museum's rare books collection. The bible was published in 1813 and donated to the USS *President* by the Nassau Hall (Princeton) Bible Society (Brenckle 2011, pers. comm.). There is a sheet of paper glued to the inside of the volume which reads

> Be it known that this Bible was taken from the Montgomery gun of the <u>President Frigate</u> where it was slung to the carriage of the said gun. It was taken by William Clark from where it hung after the engagement with the said Frigate, in December 1814 [sic]. He being master at arms and one of those that boarded the said President Frigate and as a further explanation, every gun of the said Frigate was named after some general or patriot of the United States and there was a Bible slung to the carriage of each gun and had the same name marked on the cover. This Bible was kept by me in remembrance of my brother the said William Clark, who departed this life in January 1819. <u>Charles Clark</u> (Brenckle 2011, pers. comm.).

Exactly why bibles were hung on the USS *President*'s gun carriages is unknown but they may have been placed there "as a sort of talisman to ward off evil and to protect the gun crew" (Brenckle 2011, pers. comm.). Though this practice does not involve markings such as those found on the QAR aprons, it does show a link between protective customs/superstitions and ships' guns.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on information collected in the cultural data forms, historical research, and comparative analysis, certain conclusions can be drawn about the QAR cannon aprons and about cannon aprons in general. In the first chapter of this study, three questions were posed to help guide the research. Revisiting these questions shows that the research has, for the most part, been successful. Not all aspects of the research questions were addressed, but this is not unexpected since the present study is among the first of its kind and meant to serve as groundwork from which to build future cannon apron studies.

The first research question pertained to the definition of cannon aprons as described in historical accounts. Documentary research revealed that aprons are unanimously defined as sheets of lead lashed over the vent field or touchhole of a loaded gun to keep the charge dry, keep the chamber debris free, and prevent accidental firing (Smith 1627, 1691:89; Binning 1677:109; Seller 1691:158; Povey 1702:43-46; Smith 1779:9; Tousard 1809:132,136; Simmons 1812:104; Adye 1813:2; James 1821:19; Blackmore 1976:218; Boudriot 1986:169; Caruana 1994:73). Primary sources do not detail how or where aprons were manufactured, but they seem to indicate a trend from "homemade," unstandardized objects made as needed by gunners while at sea, to prefabricated standardized objects acquired as part of ship's stores before departure. Lead was the most frequently used and preferred material for aprons, but leather was used as well. Historical sources alone do not provide a date range for apron usage, but in conjunction with archaeological examples, it appears that they were an understated accessory for gunners from the mid-16th century to the mid-19th century. Originally they may have only been used at sea, but by the early 18th century, aprons had been incorporated into field artillery batteries as well (Povey 1702:56-59; Tousard 1809:132,136). This study produced inconclusive results regarding whether there were different types of aprons for different gun types, time periods, and geographic regions. Comparative analysis with aprons from other sites revealed that there are slight changes to apron form over time that correspond to changes in artillery (such as flintlock mechanisms and raised vent patches), but there were too few examples to make any strong claims about apron form (Bingeman 2010:126; Charles Fithian 2011, pers. comm.).

The next research question was whether or not archaeological documentation could determine if the QAR aprons had been manufactured and used in accordance with the aforementioned historical references. This question was answered with less certainty because interpreting data called for a significant degree of inference and speculation. Since cannon aprons have never been studied in detail before, there are few examples of archaeological interpretations with which to support the claims.

Based on distortion and wear around fastener holes and linear indentations that may represent base ring impressions, it is possible to confirm that the QAR aprons were used according to their primary function defined in historical sources and that most were probably in use at the time of the wrecking. An analysis of the cross-sectional edges of the aprons reveals that they were likely cut from sheet lead with a hammer and chisel and the outside edges were then filed. This information, paired with the irregularity of the QAR aprons, supports the hypothesis that they were not prefabricated, but homemade.

Markings like the wrigglework symbols suggest that there was a QAR crew member familiar with metalworking techniques used to decorate pewter and bronze. The apotropaic associations of these and other markings also suggest that the aprons may have had a secondary function as protective talismans for the gun crew. Speculative as they may be, it is important to report these claims because they represent groundwork for future apron studies to either support or disprove.

Aspects of this research question that were not fully answered relate to whether the aprons' provenience is indicative of their use and whether or not it is possible to determine which aprons were used on which guns. Both issues are difficult to address because excavation and conservation are not complete. A preliminary distribution analysis of apron find locations revealed a close proximity to gun find locations, but these results will remain inconclusive until the site is fully excavated. Similarly, the second aspect of the research question was omitted because only 6 of the 24 cannon identified on site have completed conservation treatment and it would be nearly impossible to match an apron to a fully concreted gun tube.

The third research question pertained to the aprons' original surfaces, determining what chemical and physical variables have affected them and how. XRF data confirmed the aprons are made of almost pure lead and a conservation literature review was used to identify common lead corrosion products. Visual investigation of the aprons suggested that they had no unstable corrosion. Other factors that affected the aprons' surfaces include concretion from in situ proximity to iron artifacts and conservation treatments. The degree to which conservation treatments affected the surfaces seems proportional to the level of concretion. Aprons with little or no concretion were usually treated with one or two hydrochloric acid baths, a sodium sulfate rinse/scrub, and minimal mechanical cleaning. Heavily concreted aprons required more intense methods. Acid baths alone could not remove the concretion, so an alternating process of air scribing and acid poultices was used. This treatment was successful in removing concretion but caused some minor damage to the artifact's surface.

Recommendations for Further Research

In Chapter 2, it was noted that certain Material Culture Studies theories rely far too heavily on subjective data and that researchers run the risk of ascribing their own worldviews to the objects they attempt to interpret. Every effort was made during the course of this project to interpret the assemblage with empirical methods utilizing as much quantitative data as possible. Due to the nature of the study, however, this was simply not possible at all times. The study of the wrigglework markings analysis, for example, is not conducive to quantitative research. Until there are other examples of aprons with these markings, they can only be analyzed qualitatively. If no other examples are discovered, the QAR aprons with wrigglework will be shown as unique, but this assumption cannot be made until further research is conducted.

Many suggestions can be made for future work on cannon aprons, beginning with a recommendation for more comparative analysis. The QAR assemblage is far too small for statistical analysis, and too few aprons from other sites were investigated because they were difficult to locate. This may be due to misidentification of aprons as lead patches or sheathing, as indicated by the potential aprons recovered from the Chandeleur Ballast Pile and the western English Channel. Hopefully this study will lead to the identification of more aprons from other sites which can then be incorporated into a follow up study. Comparative analyses will strengthen the study by adding to information on how apron forms change (or stay the same) over time and location. Certain patterns have begun to emerge in apron research, but archaeological interpretations of these patterns will require more comparative analysis so they can be made with stronger conviction.

Another recommendation for further research is a re-evaluation of the current study after complete excavation of the QAR site and the artifact conservation. Certain aspects of the research, such as the in situ distribution of artifacts, depend on data from the fully excavated site. More aprons will likely be recovered to add to the database. During the fall 2011 field season, two large concretions were recovered that appear to contain lead aprons. These objects were not included in the present study because they require intensive conservation treatments before analysis, but they do suggest that there are other aprons on site for additional research.

Other recommendations include expanding the literature review to include more primary source material from other countries and information on 18th century lead sheet manufacture. Gunners' manuals and treatises proved invaluable to the apron research presented herein, but largely English sources were accessed. Treatises from other countries could provide insight into whether or not apron use and form followed similar standards in other parts of the world or if it varied from English use. Information on 18th century lead manufacture may be able to confirm (or refute) the idea that the aprons were cut from sheet lead and filed. It is possible that the rounded cross-sectional shape of the apron edges could be explained by sheet lead manufacturing techniques rather than by apron manufacturing techniques; this bears further investigation.

Overall the present study has been a success in shedding light on a class of artifacts that previously warranted little attention. Further research including more comparative analysis will strengthen the work and make it less particularistic. As it stands, the project has made great strides towards filling gaps in the current knowledge of 18th century maritime ordnance and towards bringing previously unknown behaviors to light.

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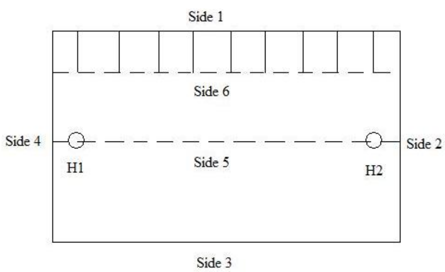
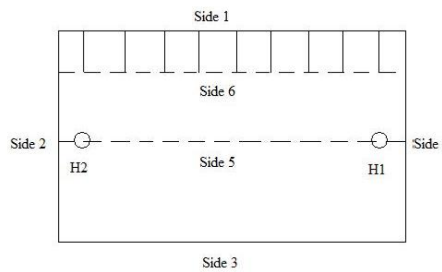
APPENDIX A: CULTURAL DATA FORM TEMPLATE

Cannon Apron Cultural Data Form
QAR No.: 1269.000 Sheet No.:
Initials: Date:

Face A

Face B



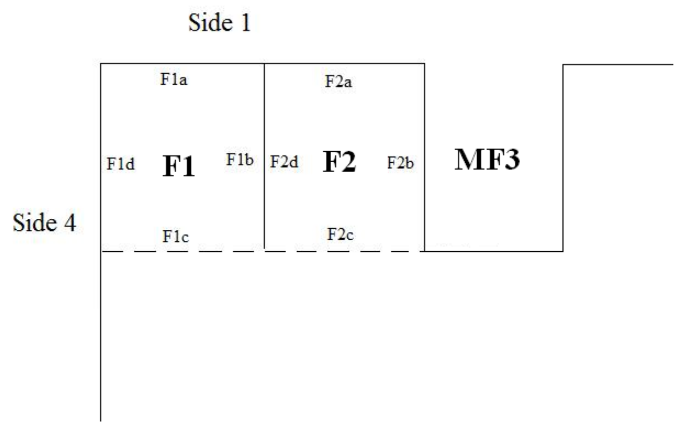


Sides:
Note-Side 5 shall be measured from the edge of Side 4 to the edge of Side 2, through the centers of H1 and H2
Side 6 shall be measured across the base of the fingers

Side	Length along folds (mm)	Total Length	Cross-section Edge (circle one of the following)			
1			Rounded	Unifacial	Bifacial	Unknown
2			Rounded	Unifacial	Bifacial	Unknown
3			Rounded	Unifacial	Bifacial	Unknown
4			Rounded	Unifacial	Bifacial	Unknown
5						
6						

Notes on Sides: ____

Fingers:
Note-Fingers shall be designated as F1, F2, F3, etc. in numerical order with F1 being the finger closest to Side 4. Missing fingers will be designated as MF1, MF2, etc. in numerical order with the existing fingers. Finger sides shall be designated (Face A up) as the finger number followed by a, b, c, or d, with F1a being aligned with Side 1.



Total number of fingers: _____________
Number of existing fingers: __________
Number of missing fingers: __________

Finger Dimensions (mm):

	F1	F2	F3	F4	F5	F6	F7	F8	F9
a									
b									
c									
d									

Cross-section of Finger Edges:
Note-Designate each edge as one of the following
A) rounded B) unifacial C) bifacial D) torn/broken E) unknown

	F1	F2	F3	F4	F5	F6	F7	F8	F9
a									
b									
c									
d									

Notes on Fingers: ____
____
____
____
____
____
____
____

Fastener Holes:
Note-Holes shall be designated as H1 and H2 with H1 adjacent to Side 4 and H2 adjacent to Side 2. Additional holes shall be designated as H3 and/or H4.

Number of holes: __________

Shape of H1: circular rectangular/square triangular other_________________
Shape of H2: circular rectangular/square triangular other_________________
Shape of H3: circular rectangular/square triangular other_________________
Shape of H4: circular rectangular/square triangular other_________________

Dimensions of holes (mm):

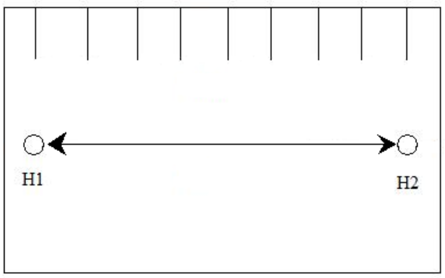
	H1	H2	H3	H4
Side a				
Side b				
Side c				
Side d				
Diameter (if circular)				

Cross-section Edge of Holes:

					Excess Lead from Reaming		
H1	Rounded	Unifacial	Bifacial	Unknown	Slough on Face A	Slough on Face B	Both
H2	Rounded	Unifacial	Bifacial	Unknown	Slough on Face A	Slough on Face B	Both
H3	Rounded	Unifacial	Bifacial	Unknown	Slough on Face A	Slough on Face B	Both
H4	Rounded	Unifacial	Bifacial	Unknown	Slough on Face A	Slough on Face B	Both

Distance between H1 and H2 (mm): ___________________________

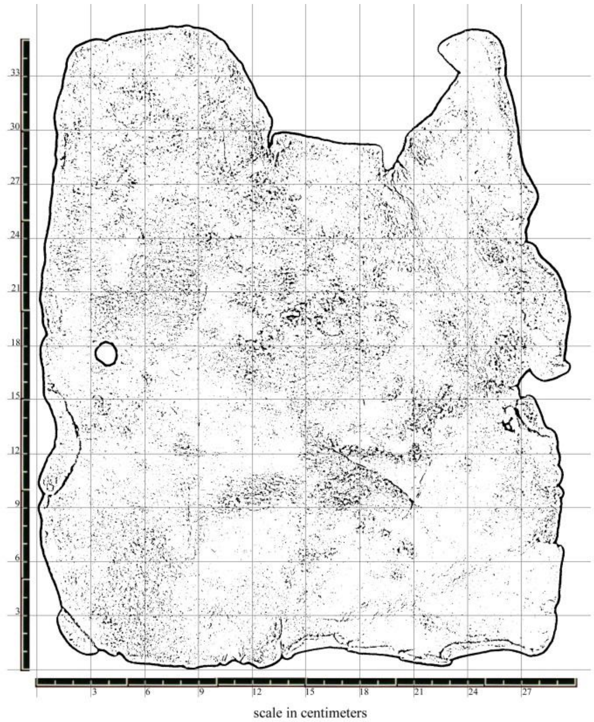
Note-Measure along Side 5, from the inside edge of H1 to the inside edge of H2.



Notes on Holes: ____
____
____
____
____
____

Thickness:

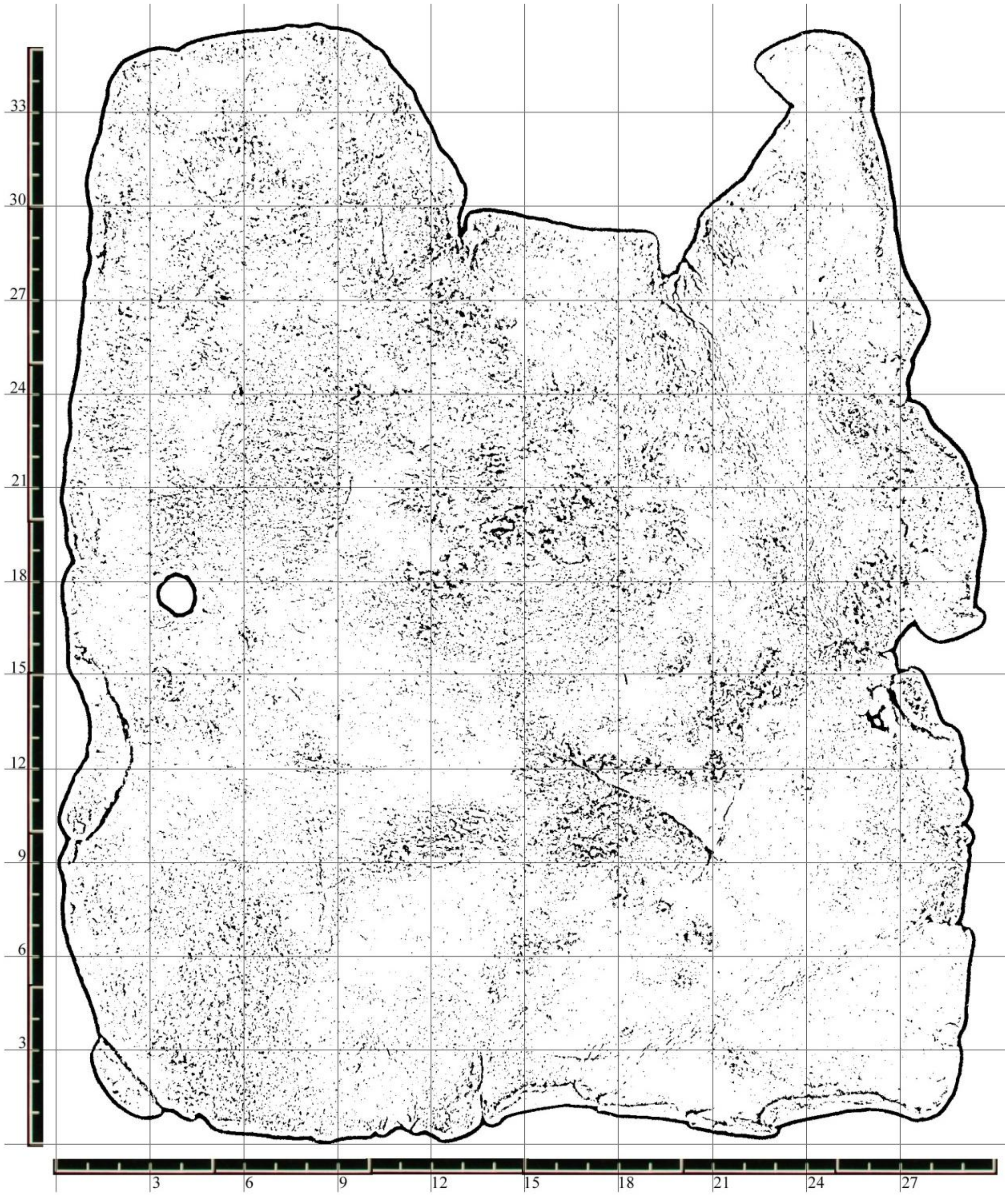
Note-Label the points where thickness is measured and be sure to include the distances from the edges. Also record the thicknesses of the centers of the fingers if possible.



Point	Thickness (mm)	Distance from Edge (mm)
1		
2		
3		
4		
5		
F1		
F2		
F3		
F4		
F5		
F6		
F7		
F8		
F9		

Sketch markings, graffiti, and areas of corrosion to scale on the chart below. Use the Notes section to record detailed dimensions, colors, and additional descriptions.

Face A

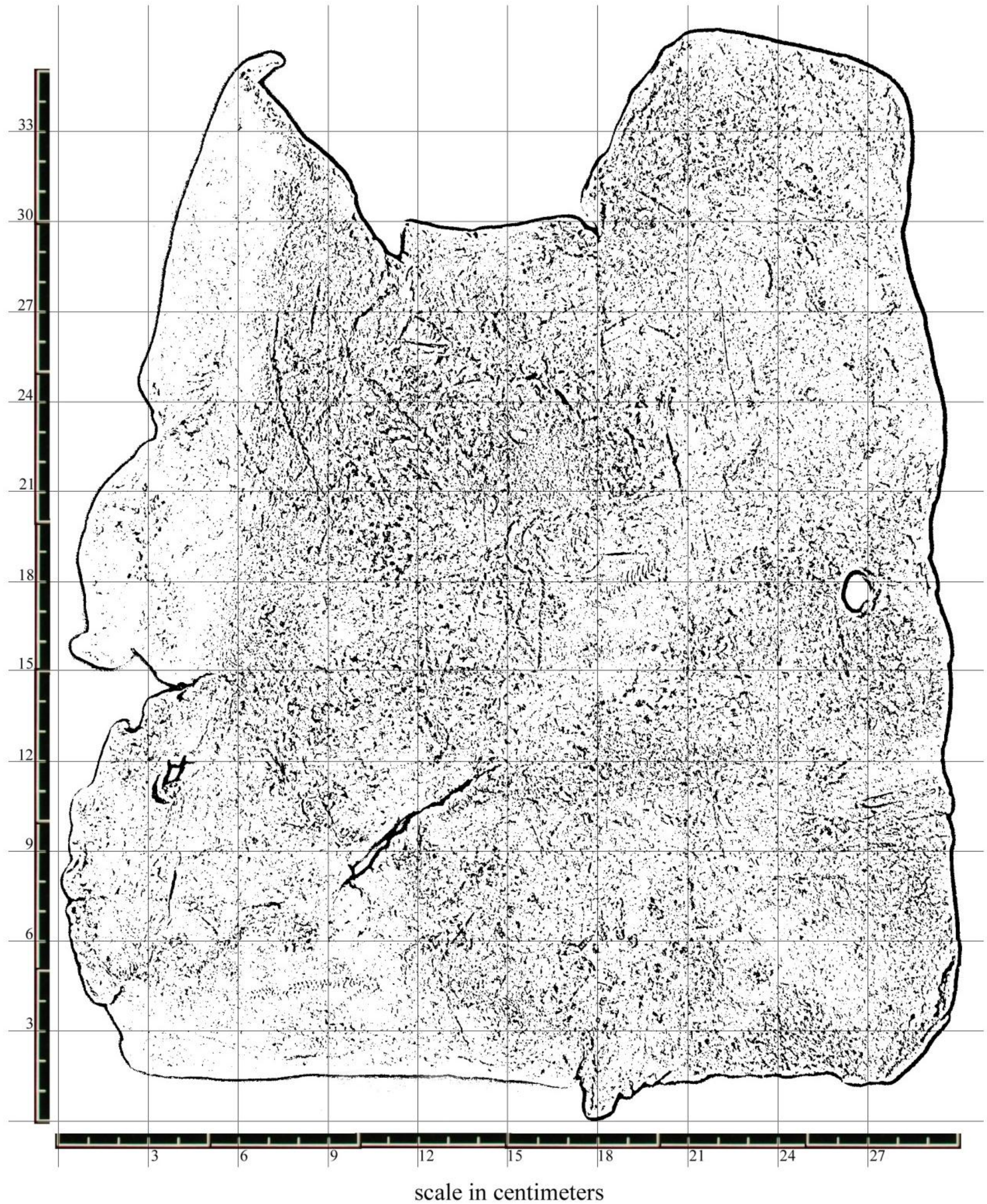


scale in centimeters

Notes: ____

Sketch markings, graffiti, and areas of corrosion to scale on the chart below. Use the Notes section to record detailed dimensions, colors, and additional descriptions.

Face B



Notes: ____

APPENDIX B: XRF DATA

QAR #	0002.000	1497.000	1497.000	1513.000	1513.000
Remarks	Cannon Apron	Cannon Apron - center of apron to film, side 1	Cannon Apron - center of apron to film, side 2	Cannon Apron - center of apron to film, side 1	Cannon Apron - center of apron to film, side 2
Mode	Analytical	Analytical	Analytical	Analytical	Analytical
Live	21.32	20.08	20.08	21.46	20.78
LE	ND	ND	ND	ND	ND
LE +/-					
P	NA	NA	NA	NA	NA
P +/-					
S	NA	NA	NA	NA	NA
S +/-					
Cl	NA	NA	NA	NA	NA
Cl +/-					
K	NA	NA	NA	NA	NA
K +/-					
Ca	NA	NA	NA	NA	NA
Ca +/-					
Ti	ND	ND	ND	ND	ND
Ti +/-					
V	ND	ND	ND	ND	ND
V +/-					
Cr	ND	ND	ND	ND	ND
Cr +/-					
Mn	ND	ND	ND	ND	ND
Mn +/-					
Fe	ND	0.57	0.27	ND	1.16
Fe +/-		0.04	0.04		0.06
Co	ND	ND	ND	ND	ND
Co +/-					
Ni	ND	ND	ND	ND	ND
Ni +/-					
Cu	ND	0.18	0.10	0.23	0.23
Cu +/-		0.02	0.02	0.02	0.02
Zn	ND	ND	ND	ND	ND
Zn +/-					

As	NA	NA	NA	NA	NA
As +/-					
Se	NA	NA	NA	NA	NA
Se +/-					
Br	NA	NA	NA	NA	NA
Br +/-					
Rb	NA	NA	NA	NA	NA
Rb +/-					
Sr	NA	NA	NA	NA	NA
Sr +/-					
Zr	ND	ND	ND	ND	ND
Zr +/-					
Nb	ND	ND	ND	ND	ND
Nb +/-					
Mo	ND	ND	ND	ND	ND
Mo +/-					
Rh	ND	ND	ND	ND	ND
Rh +/-					
Pd	ND	ND	ND	ND	ND
Pd +/-					
Ag	ND	ND	ND	ND	ND
Ag +/-					
Cd	NA	NA	NA	NA	NA
Cd +/-					
Sn	ND	ND	ND	ND	ND
Sn +/-					
Sb	ND	ND	ND	ND	ND
Sb +/-					
I	NA	NA	NA	NA	NA
I +/-					
Ba	NA	NA	NA	NA	NA
Ba +/-					
Hf	ND	ND	ND	ND	ND
Hf +/-					
Ta	ND	ND	ND	ND	ND
Ta +/-					
W	ND	ND	ND	ND	ND
W +/-					
Re	ND	ND	ND	ND	ND

Re +/-					
Ir	ND	ND	ND	ND	ND
Ir +/-					
Pt	ND	ND	ND	ND	ND
Pt +/-					
Au	ND	ND	ND	ND	ND
Au +/-					
Hg	NA	NA	NA	NA	NA
Hg +/-					
Pb	100	99.25	99.63	99.77	98.62
Pb +/-	0.42	0.39	0.40	0.40	0.41
Bi	ND	ND	ND	ND	ND
Bi +/-					
Pa	NA	NA	NA	NA	NA
Pa +/-					